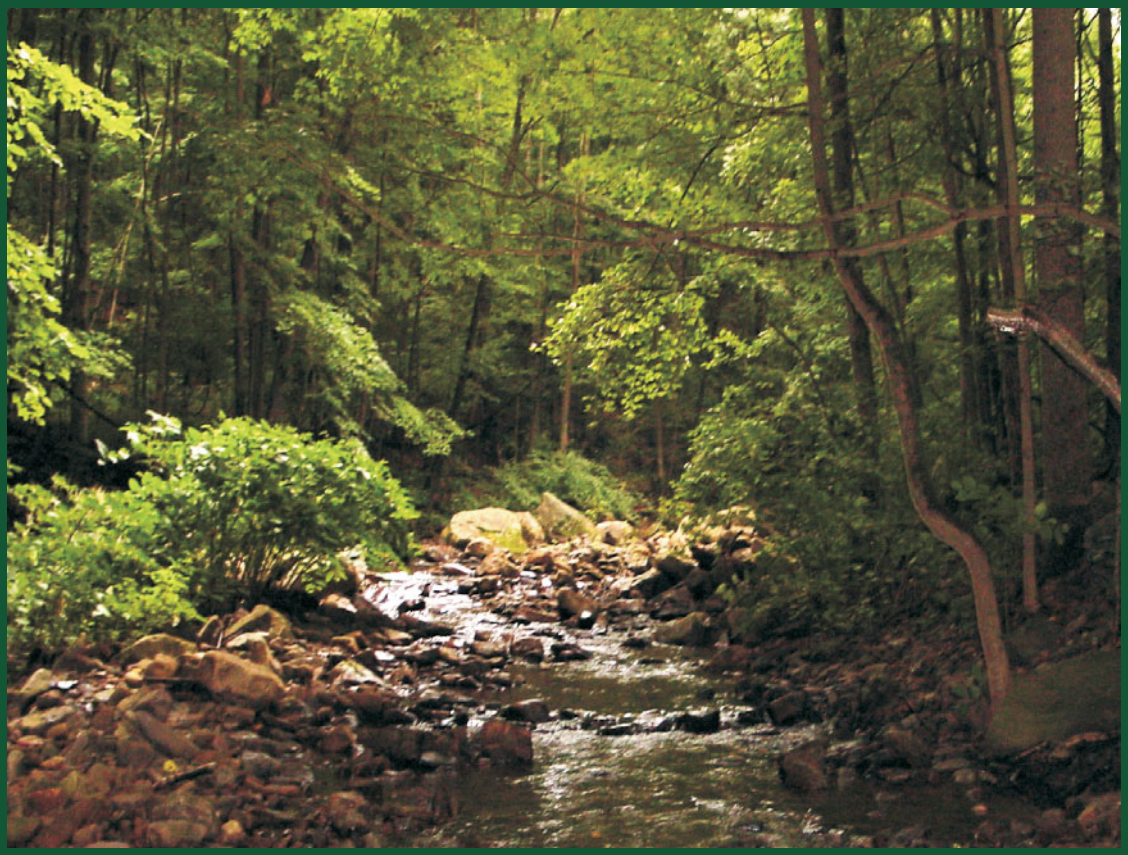
MARYLAND BIOLOGICAL STREAM SURVEY 2000-2004

Volume VII



Statewide and Basin Conditions

MARYLAND DEPARTMENT OF NATURAL RESOURCES

CHESAPEAKE BAY AND WATERSHED PROGRAMS
MONITORING AND NON-TIDAL ASSESSMENT
CBWP-MANTA-EA-05-4

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2000-2004

Volume 7:
Statewide and Tributary Basin Results

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FOREWORD

This report, *Maryland Biological Stream Survey 2000-2004 Volume 7: Statewide and Tributary Basin Results*, was prepared by Versar Inc., for the Maryland Department of Natural Resources' Monitoring and Non-Tidal Assessment Division. It was supported by Maryland's Power Plant Research Program (Contract No. K00B0200109 to Versar, Inc.).

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All aspects of the Maryland Biological Stream Survey have been a cooperative effort among Maryland DNR, several academic institutions, and consulting firms, as listed in the acknowledgements sections of each volume. For this volume, the authors would like to acknowledge the following individuals who contributed data analysis, graphical support, editing, or other talents:

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ABSTRACT

This volume reports on the stream conditions statewide and in Maryland's Tributary Strategy Basins as described by the findings of the 2000-2004 (Round 2) Maryland Biological Stream Survey (MBSS). The Tributary Basins were developed as part of Maryland's Tributary Strategy Teams.

The statewide mean fish community Index of Biotic Integrity (IBI) for the 2000-2004 MBSS is 2.97 (standard error or SE of 0.04), a high Poor, almost Fair rating. The Upper Eastern Shore Basin has the highest percentage of stream miles rated Good (46%, SE 6.2). The statewide mean benthic macroinvertebrate IBI for the 2000-2004 MBSS is 3.07 (SE 0.03), or Fair. The Lower Potomac River Basin had the highest percentage of stream miles rated Good (53%, SE 5.1). The statewide mean Combined Biotic Index (CBI; the average of fish and benthic IBI scores) is 3.00 (SE 0.03), a Fair condition rating.

The statewide mean Physical Habitat Index (PHI) score is 70.27 (SE 0.44), or Degraded. Statewide, an estimated 59% (SE 1.5) of stream miles were rated Optimal for their trash rating (scoring $\geq$ 16 out of 20), meaning trash was minimal. Only 6% (SE 0.6) of stream miles were rated as Poor for trash. The two basins with the highest number of stream miles rated Poor were the Patapsco/Back River Basin and the Middle Potomac Basin (26%, SE 3.9, and 24%, SE 4.8, respectively). These two basins encompass most of the urbanized areas of the Baltimore-Washington corridor.

During spring sampling in the 2000-2004 MBSS, an estimated 6% (SE 0.7) of stream miles statewide had pH < 5.5. The Lower Eastern Shore Basin had, by far, the most stream miles with pH < 5.5 (27% of stream miles, SE 4.8). Two Tributary Strategy Basins contained more than 10% of stream miles that were rated acidic using an Acid Neutralizing Capacity of 200 μeq/l threshold: the Lower Eastern Shore Basin (14%, SE 3.8) and the Ocean Coastal Basin (11%, SE 11.1).

Statewide, the majority of stream miles (85%, SE 1.0) had nitrate-nitrogen (NO_3) concentrations between 1.0 and 5.0 mg/l. Eight percent (SE 0.8) fell below 1.0 mg/l and seven percent (SE 0.7) fell above 5.0 mg/l. Tributary Strategy Basins containing the most stream miles with high NO_2 were the Upper Eastern Shore Basin (49%, SE 5.9), Patapsco/Back Basin (45%, SE 5.1), and the Choptank Basin (43%, SE 9.0). Statewide, only 24% of stream miles (SE 1.3) had NO_2 concentrations above 0.01 mg/l. Also, the majority of stream miles in the state (70%, SE 1.3) had low ammonia concentrations (< 0.03 mg/l). Forty-seven percent (SE 1.4) of stream miles had total nitrogen concentrations that fell between 1.5 and 7.0 mg/l. The majority (54%, SE 1.4) of stream miles have low (< 0.025 mg/l) concentrations of total phosphorus. The Tributary Strategy Basins with the greatest number of stream miles with high (> 0.07 mg/l) concentrations of total phosphorus are located on the Eastern Shore. Ortho-phosphate patterns were similar to those of total phosphorus. The majority of stream miles (88%, SE 1.0) statewide had dissolved oxygen (DO) concentrations greater than 5 mg/l. As expected, the greatest number of stream miles with low DO (< 3 mg/l) concentrations occurs on the Eastern Shore, where swampy, blackwater conditions with low DO and pH are natural.

These results confirm that a large proportion of our streams are in poor condition and many more are in worse condition than we desire. The first step in "fixing" these streams is determining why they are "broken." The MBSS is pursuing stressor identification (i.e., the diagnosis of stream problems) for the degraded streams identified in this volume to support stream protection and restoration efforts by Maryland DNR, MDE, and other organizations (see Volume 14 Stressors Affecting Maryland Streams). These results also show where Maryland streams are in their best condition (IBIs > 4 or higher). These streams warrant special attention for protection as well (see Volume 9 Stream and Riverine Biodiversity).

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7.1 INTRODUCTION

This volume reports on the stream conditions statewide and in Maryland's Tributary Strategy Basins as described by the findings of the Maryland Biological Stream Survey (MBSS). Unlike many other monitoring programs, the Survey is probability-based and can therefore estimate the condition of all first- through fourth-order non-tidal streams with known confidence. This volume contains stream condition estimates derived from data collected in the 2000 to 2004 Survey.

In addition to statewide results, this volume presents results for the each of the 10 Tributary Strategy Basins that drain to the Chesapeake Bay (Figure 7-1), as well as the Youghiogheny River Basin (which drains to the Ohio River) and the Ocean Coastal Basin (which drains to the Atlantic Ocean). These basins were developed as part of the Maryland Department of Natural Resources Tributary Strategy Teams. Each team is comprised of local citizens, farmers, business leaders, and government officials. The teams meet regularly to help implement pollution prevention measures needed to address local water quality problems. A major focus of their efforts is controlling nutrient pollution from farm fields and horse pastures, wastewater treatment plants, and suburban development. To that end, this volume presents results from physical, chemical, and biological sampling conducted during 2000-2004, with a particular focus on nutrients at the level of the Tributary Strategy Basins.

While this volume focuses on results at the statewide and Tributary Strategy Basin level, other volumes of the 2000-2004 MBSS report present results at different scales (for example, Volume 8 examines results at the county level for each of the 23 counties in Maryland, as well as Baltimore City). Other volumes in this series likely to be of particular interest to the reader are the volumes on biodiversity (Volume 12) and stressors (Volume 14). To limit the size and complexity of this volume and to increase readability, all methods used to prepare and analyze data are presented in Volume 6. This volume and others can be downloaded from www.dnr.state.md.us/streams/mbss/mbss_pubs.html.

7.1.1 DESCRIPTION OF THE MBSS

The MBSS is intended to help environmental decision-makers protect and restore the natural resources of Maryland. The primary objectives of the MBSS are to

- assess the current status of biological resources in Maryland's non-tidal streams;
- quantify the extent to which acidic deposition has affected or may be affecting biological resources in the state;
- examine which other water chemistry, physical habitat, and land use factors are important in explaining the current status of biological resources in streams;
- compile the first statewide inventory of stream biota;
- establish a benchmark for long-term monitoring of trends in these biological resources; and
- target future local-scale assessments and mitigation measures needed to restore degraded biological resources.

To meet these and other objectives, the MBSS implemented a random sampling design to allow for unbiased estimates of physical, chemical, and biological conditions for the entire state, a particular basin, or for subpopulations of special interest (Klauda et al. 1998). The MBSS has also (1) implemented sampling protocols and quality assurance/quality control procedures to assure data quality and precision, (2) developed indicators of biological condition so that degradation can be evaluated as a deviation from reference expectations, and (3) used a variety of analytical methods to evaluate the relative contributions of different anthropogenic stresses.

MBSS field data were collected from a representative sample of at least ten 75-m stream segments from each Maryland 8-digit watershed (or combination of smaller watersheds) using both quantitative and qualitative methods. Benthic macroinvertebrate and water quality sampling were conducted in spring,

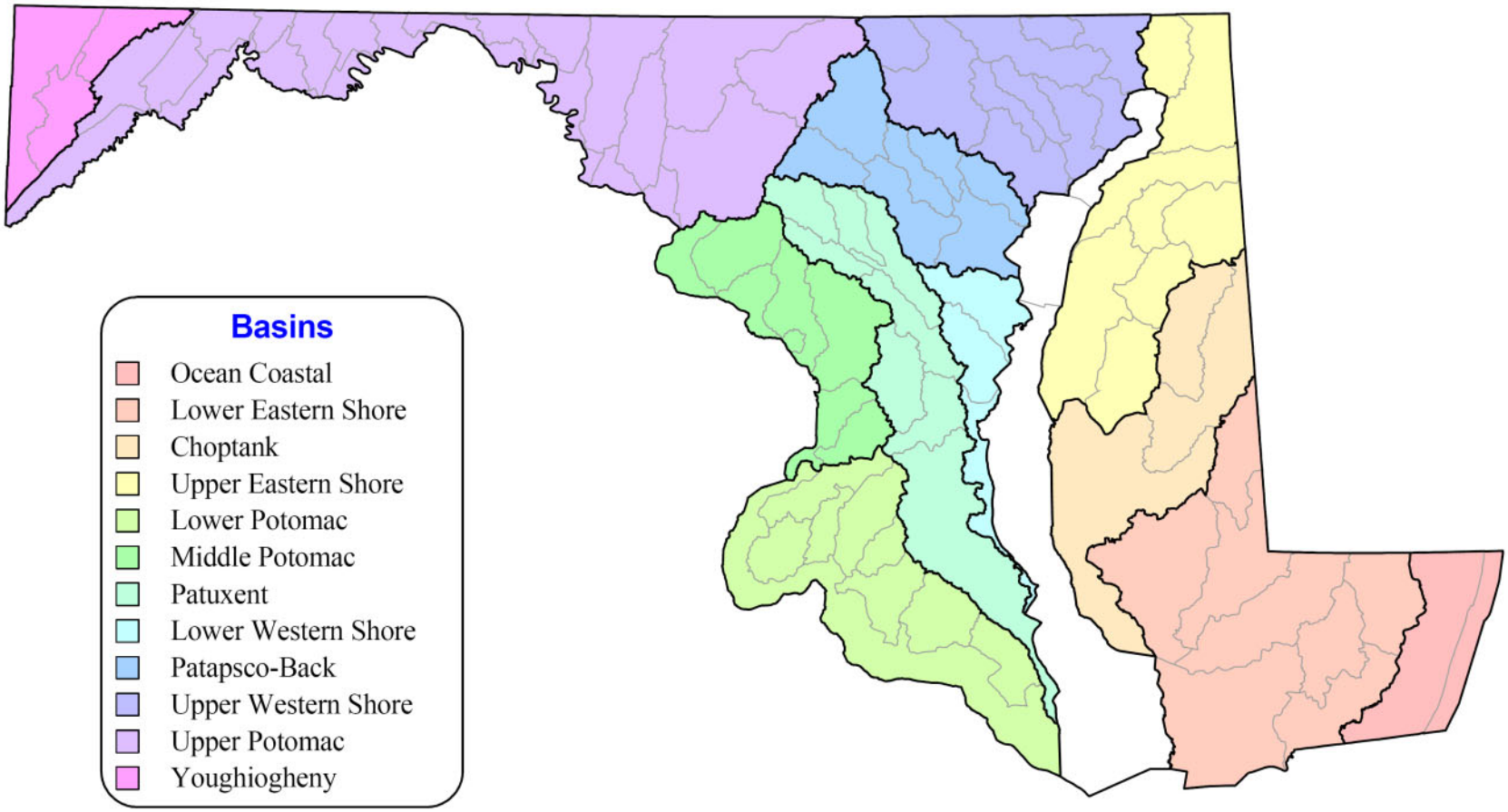

Figure 7-1. Chesapeake Bay Tributary Strategy Basins, including the Youghiogheny River Basin and the Ocean Coastal Basin (both of which do not drain to the Chesapeake Bay, but are included in the Maryland Biological Stream Survey)

when acidic deposition effects are often the most pronounced. Fish, amphibian, reptile, and aquatic vegetation surveys, along with physical habitat evaluations, were conducted during the low-flow period in summer.

7.2 BIOTIC INTEGRITY

The Index of Biotic Integrity is a stream assessment tool that evaluates the biological integrity at a site based on characteristics of the fish and benthic macroinvertebrate assemblages at a site. Biological integrity is defined as "the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region (Karr and Dudley 1981 as cited in Karr 1991)."

Fish and benthic macroinvertebrate Indices of Biotic Integrity (IBIs) for the State of Maryland were originally developed for use during the first round of MBSS sampling, which took place in 1995-1997 (Roth et al. 2000, Stribling et al. 1998). These IBIs were revised at the conclusion of the second round of sampling in 2004 (Southerland et al 2005). The revised IBIs are reported in this volume.

The MBSS computes the IBI as the average of individual metric scores. Individual metric scores are based on comparison with the distribution of metric values at reference sites (minimally disturbed) within each geographic or stream type stratum. Metrics are scored 1 (if $< 10^{th}$ percentile of reference value), 3 (10^{th} to 50^{th} percentile), or 5 ($\geq 50^{th}$ percentile). The final IBI scores are calculated as the average of these scores and therefore range from 1 to 5. An IBI ≥ 3 indicates the presence of a biological community with attributes comparable to those of reference sites, while an IBI < 3 means that, on average, metric values fall short of reference expectations.

Table 7-1 contains narrative descriptions for each of the IBI categories developed for the MBSS. Because an IBI score of 3 represents the threshold of reference condition, values less then 3 (i.e., poor or very poor) represent sites that are degraded. In contrast, values greater than or equal to 3 (i.e., fair or good) indicate that most attributes of the community are within the range of those at reference sites and therefore not degraded. The assignment of scores to narrative categories is a useful method for translating scores into a form that is easily communicated.

7.2.1 Fish Index of Biotic Integrity

The statewide mean fish IBI for the 2000-2004 MBSS is 2.97 (standard error or SE of 0.04), a rating at the top end of the Poor condition category. Statewide, an estimated 26% (SE 1.4) of stream miles were rated Good, 25% (SE 1.5) of stream miles were rated Fair, 21% (SE 1.4) were rated Poor, 19% (SE 1.3) were rated Very Poor, and 9% (SE 0.9) were Not Rated. Streams were not rated for the fish IBI if they were natural blackwater streams or if they were not sampled because the stream was dry during the summer.

Figure 7-2 shows the percentage of stream miles in each fish IBI condition class for each of the Tributary Strategy Basins. The Upper Eastern Shore Basin has the highest percentage of stream miles rated Good (46%, SE 6.2), followed by the Patapsco/Back River Basin (36% of miles rated Good, SE 4.5). The Lower Western Shore Basin has the highest percentage of stream miles rated Very Poor for the fish IBI (49%, SE 8.6). Figure 7-3 shows the distribution of mean fish IBI scores statewide according to MBSS-design-based Primary Sampling Units (PSUs). PSUs are single or combined marginal 8-digit watersheds which included 10 or more MBSS sample sites.

Table 7-1. Narrative descriptions of stream biological integrity with each of the IBI categories

Good	IBI score 4.0-5.0	Comparable to reference streams considered to be minimally disturbed. On average, biological metrics fall within the upper 50% of reference site conditions.
Fair	IBI score 3.0-3.9	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of these minimally disturbed streams. On average, biological metrics fall within the lower portion of the range of reference sites (10^{th} to 50^{th} percentile).
Poor	IBI score 2.0-2.9	Significant deviation from reference conditions, with many aspects of biological integrity not resembling the qualities of these minimally disturbed streams, indicating degradation. On average, biological metrics fall below the 10^{th} percentile of reference site conditions.
Very Poor	IBI score 1.0-1.9	Strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of these minimally disturbed streams, indicating severe degradation. On average, biological metrics fall below the 10^{th} percentile of reference site values; most or all metrics are below this level.

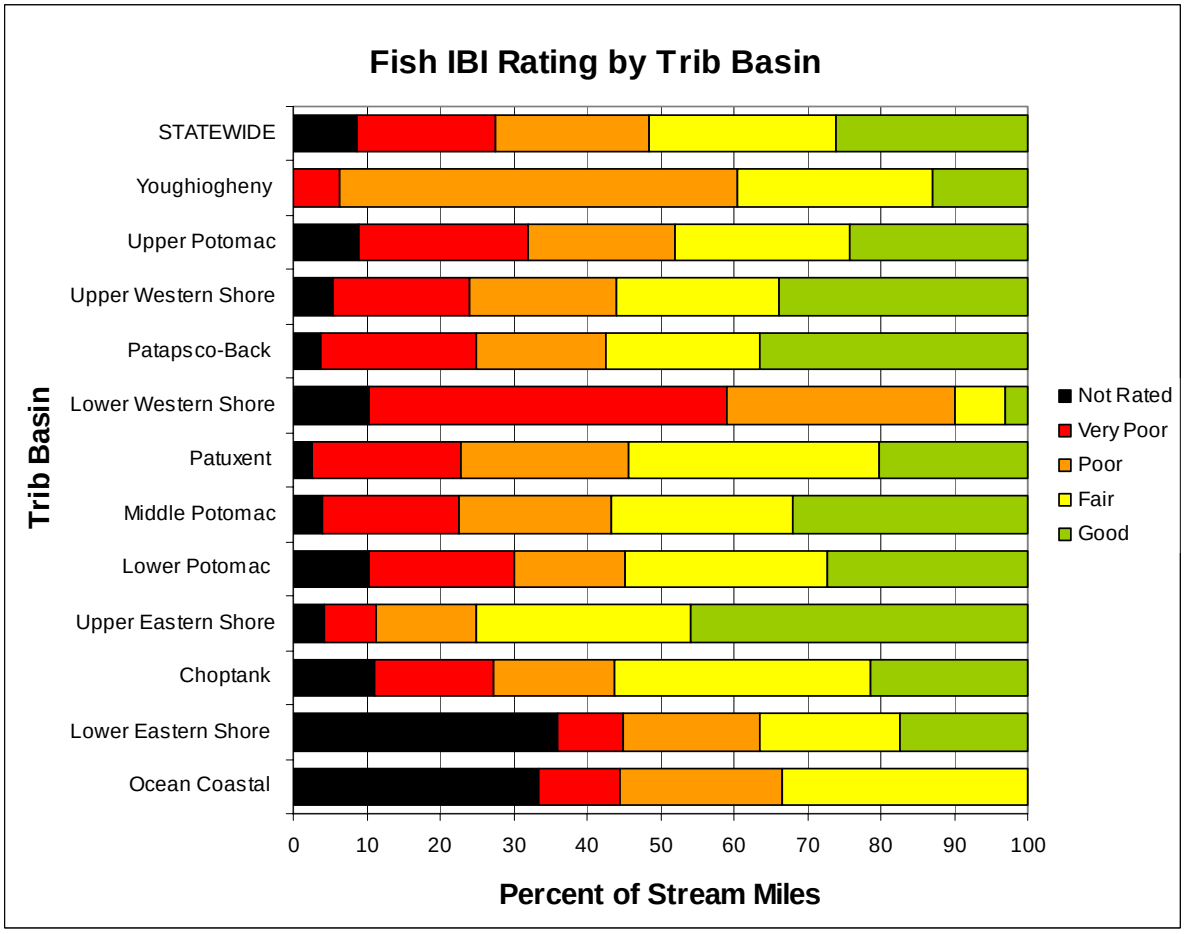

Figure 7-2. Fish Index of Biotic Integrity (IBI) scores statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: 4.0-5.0 good, 3.0-3.9 fair, 2.0-2.9 poor, and 1.0-1.9 very poor. Sites that were not rated are either blackwater sites or were not sampled in the summer index period.

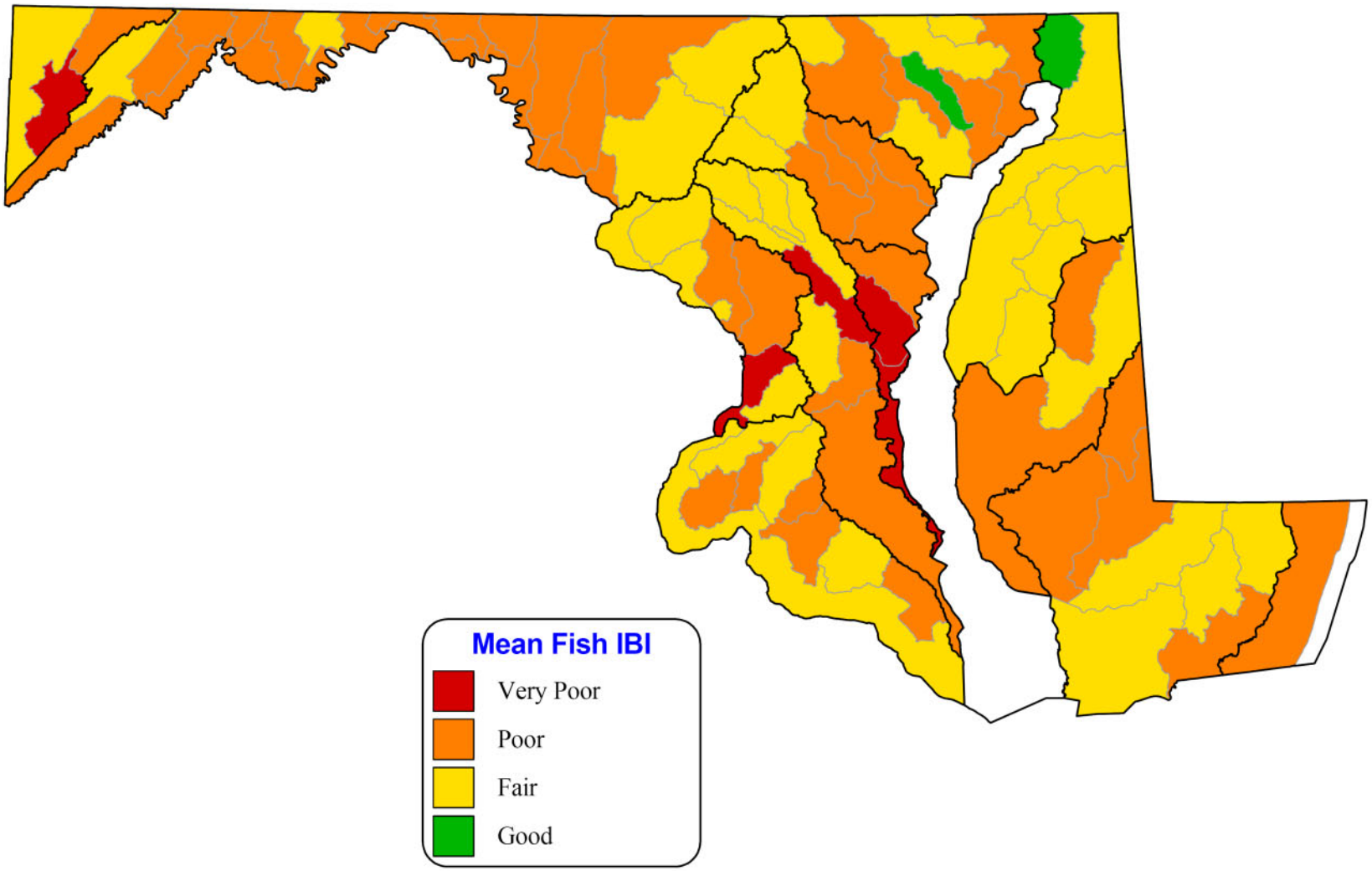

Figure 7-3. Distribution of mean Fish Index of Biotic Integrity sites (FIBI) by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. Fish IBI categories are 4.0-5.0 good, 3.0-3.9 fair, 2.0-2.9 poor, and 1.0-1.9 very poor.

7.2.2 Benthic Index of Biotic Integrity

The statewide mean benthic IBI for the 2000-2004 MBSS is 3.07 (SE 0.03), in the low end of the Fair condition category. Statewide, an estimated 26% (SE 1.3) of stream miles were rated Good, 28% (SE 1.5) were rated Fair, 30% (SE 1.5) were rated Poor, and 16% (SE 1.2) were rated Very Poor.

Figure 7-4 shows the percentage of stream miles in each benthic IBI condition class for each of the Tributary Strategy Basins. The Lower Potomac River Basin had the highest percentage of stream miles rated Good (53%, SE 5.1). The Patapsco/Back Basin and the Middle Potomac Basin both had the highest percentage of stream miles rated Very Poor (26%, SE 3.9, and 26%, SE 5.4, respectively). Figure 7-5 shows the distribution of mean benthic IBI scores statewide by PSU.

7.2.3 Combined Biotic Index

The Combined Biotic Index (CBI) is the average of fish and benthic IBI scores. While the fish and benthic IBIs provide valuable complementary information on biotic integrity (i.e., each responds differently to anthropogenic stress), the CBI is a useful indicator for community stream condition as a single number. The statewide mean Combined Biotic Index is 3.00 (SE 0.03), in the low end of the Fair condition category. Statewide, an estimated 17% (SE 1.1) of stream miles rated Good, 37% (SE 1.6) of stream miles rated Fair, 30% (SE 1.5) rated Poor, and 16% (SE 1.2) rated Very Poor.

Figure 7-6 shows the percentage of stream miles in each CBI condition class for each of the Tributary Strategy Basins. The Lower Potomac River Basin had the greatest percentage of stream miles that scored Good (35%, SE 5.0) for the CBI, while the Lower Western Shore Basin had the greatest percentage of stream miles that scored Very Poor (32%, SE 8.6) for the CBI. Figure 7-7 shows the distribution of mean CBI scores statewide, by PSU.

7.3 PHYSICAL HABITAT

7.3.1 Physical Habitat Index

The MBSS collects data to assess the extent and type of physical habitat degradation occurring in Maryland streams. A Physical Habitat Index (PHI) was developed during Round One of the MBSS and revised using Round 2 data (Paul et al. 2002). Data from the 2000-2004 MBSS sampling were analyzed to examine key physical habitat parameters that may affect biological communities. The PHI is scored as follows:

- 81 to 100 Minimally Degraded
- 66 to 80 Degraded
- 51 to 65 Partially Degraded
- 0 to 50 Severely Degraded

The statewide mean PHI score is 70.27 (SE 0.44), near the middle of the Degraded condition range. Statewide, an estimated 21% (SE 1.4) of stream miles were rated Good for PHI, 46% (SE 1.7) were rated Fair, 24% (SE 1.5) were rated Poor, and 9% (SE 1.0) were rated Very Poor.

Figure 7-8 shows the percentage of stream miles in each PHI condition class for each of the Tributary Strategy Basins. The Lower Potomac River Basin had the greatest percentage of stream miles that scored Good (37%, SE 5.1), while the Ocean Coastal Basin had the greatest percentage of stream miles that scored Very Poor (14%, SE 14.0). Figure 7-9 shows the distribution of mean PHI scores statewide by PSU.

7.3.2 Trash Rating

The trash rating (sometimes referred to as aesthetic quality) of a stream site is assessed (on a 0-20 point scale) by observing the area surrounding each sampled stream segment. While the amount of trash may not directly affect stream biota, it is often associated with other human stressors. It also characterizes the visual appeal of a site and may reflect the value humans attach to the stream.

Statewide, an estimated 59% (SE 1.5) of stream miles were rated Optimal for their trash rating (scoring $\geq$ 16 out of 20). Only 6% (SE 0.6) of stream miles were rated as Poor. Figure 7-10 shows the percentage of stream miles in each trash rating condition class for each Tributary Strategy Basin. In the Ocean Coastal Basin, 100% (SE 0.00) of the stream miles rated Optimal for trash rating, followed by the Youghiogheny River Basin (76%, SE 6.9) and the Choptank River Basin (70%, SE 8.6). The two basins with the highest number of stream miles rated Poor were the Patapsco/Back River Basin and the Middle Potomac Basin (26%, SE 3.9, and 24%, SE 4.8, respectively). These two basins encompass most of the urbanized areas of the Baltimore-Washington corridor and are probably most severely impacted by human disturbance. Figure 7-11 shows the distribution of mean trash rating scores statewide by PSU.

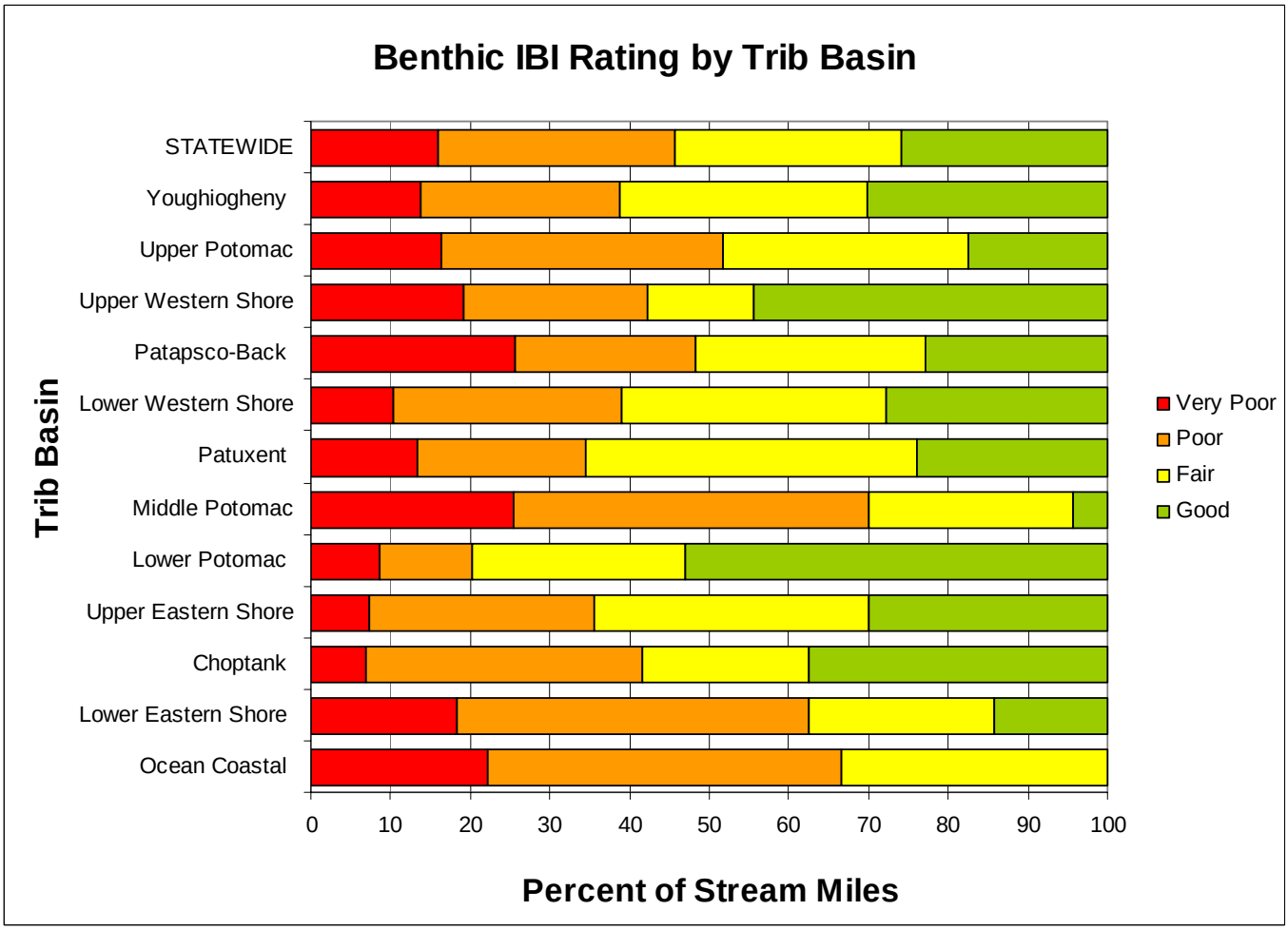

Figure 7-4. Benthic Index of Biotic Integrity (IBI) scores statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: 4.0-5.0 good, 3.0-3.9 fair, 2.0-2.9 poor, and 1.0-1.9 very poor

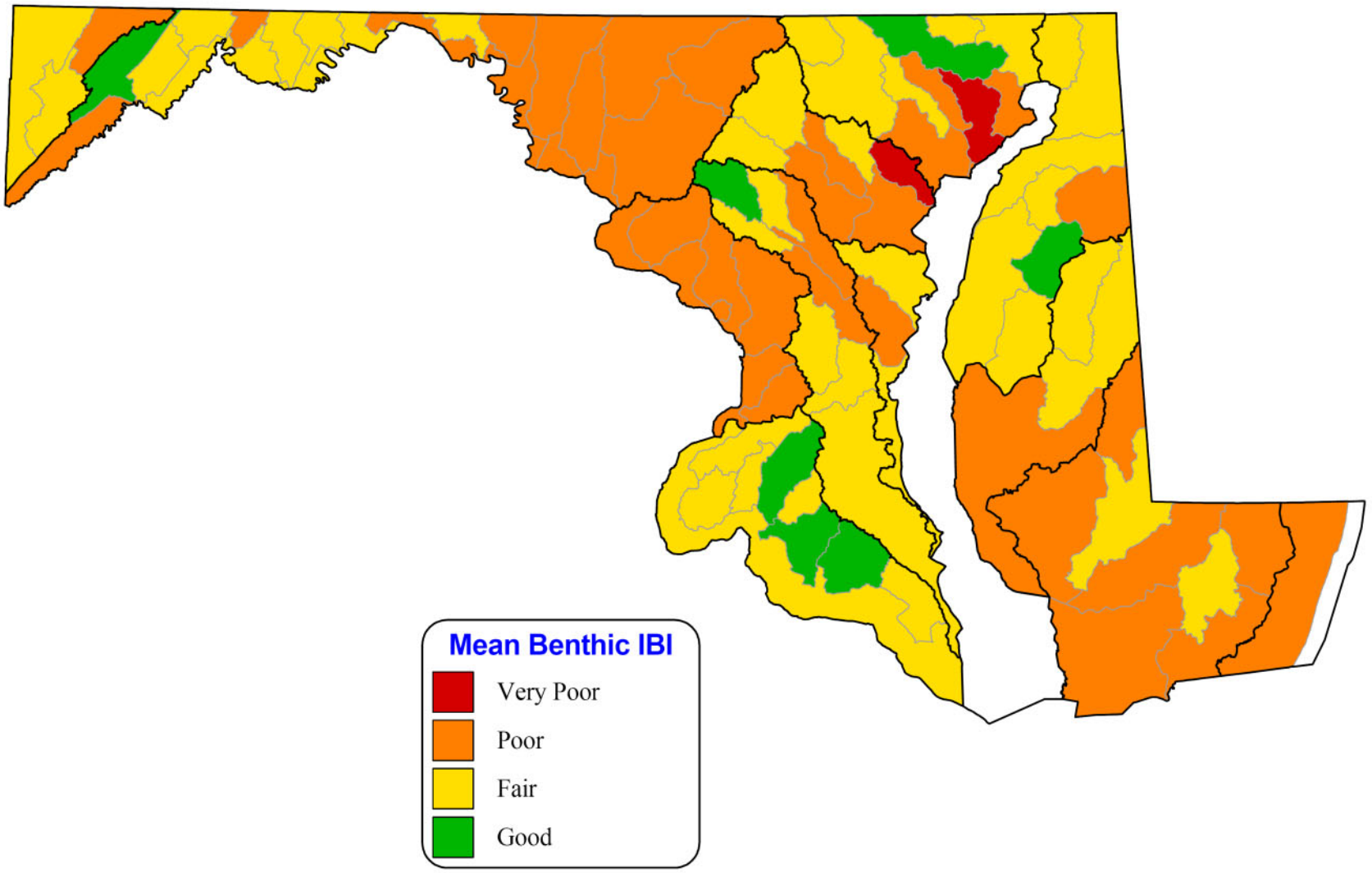

Figure 7-5. Distribution of mean Benthic Index of Biotic Integrity sites (BIBI) by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. Benthic IBI categories are 4.0-5.0 good, 3.0-3.9 fair, 2.0-2.9 poor, and 1.0-1.9 very poor.

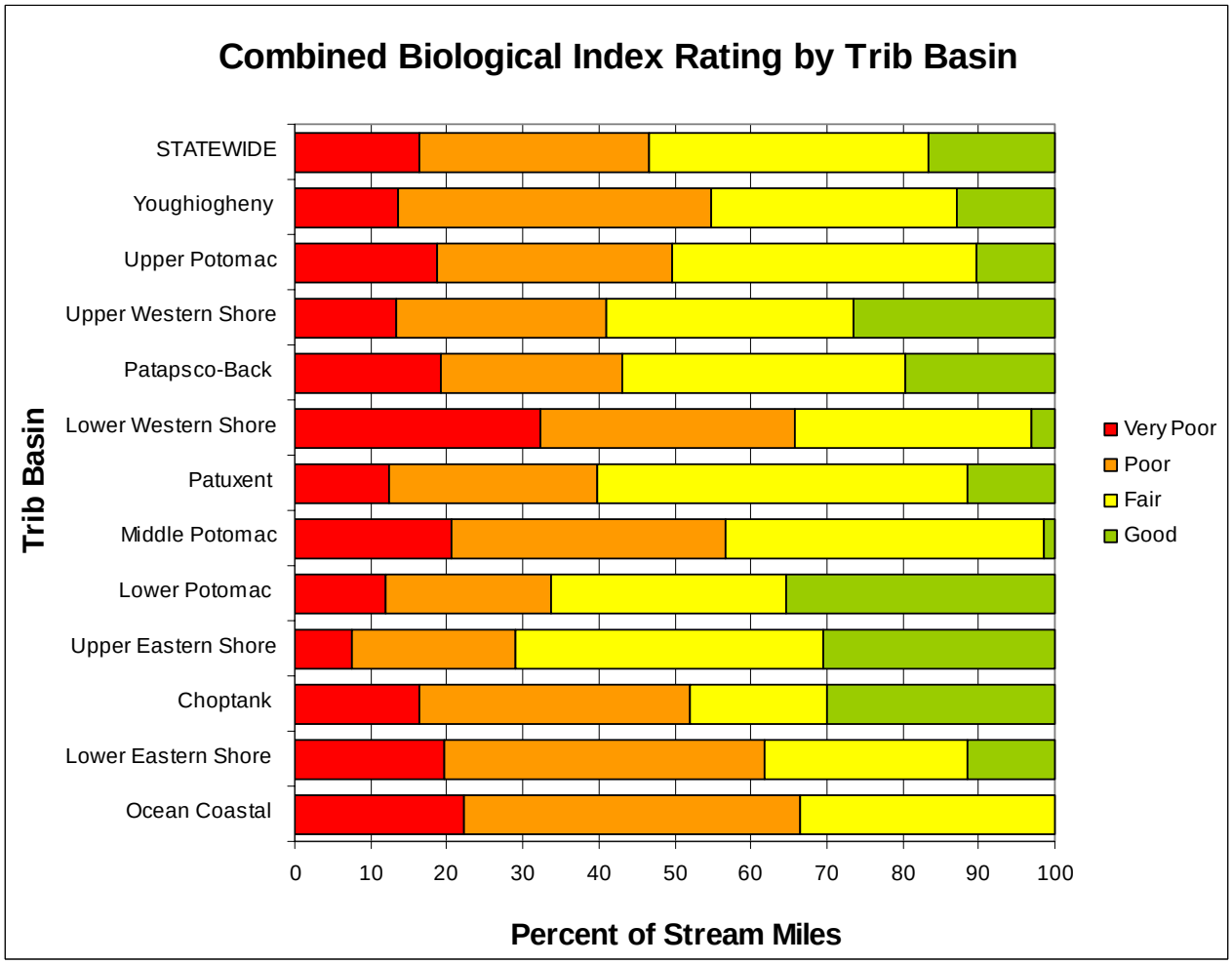

Figure 7-6. Combined Biotic Index (CBI) scores statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: 4.0-5.0 good, 3.0-3.9 fair, 2.0-2.9 poor, and 1.0-1.9 very poor

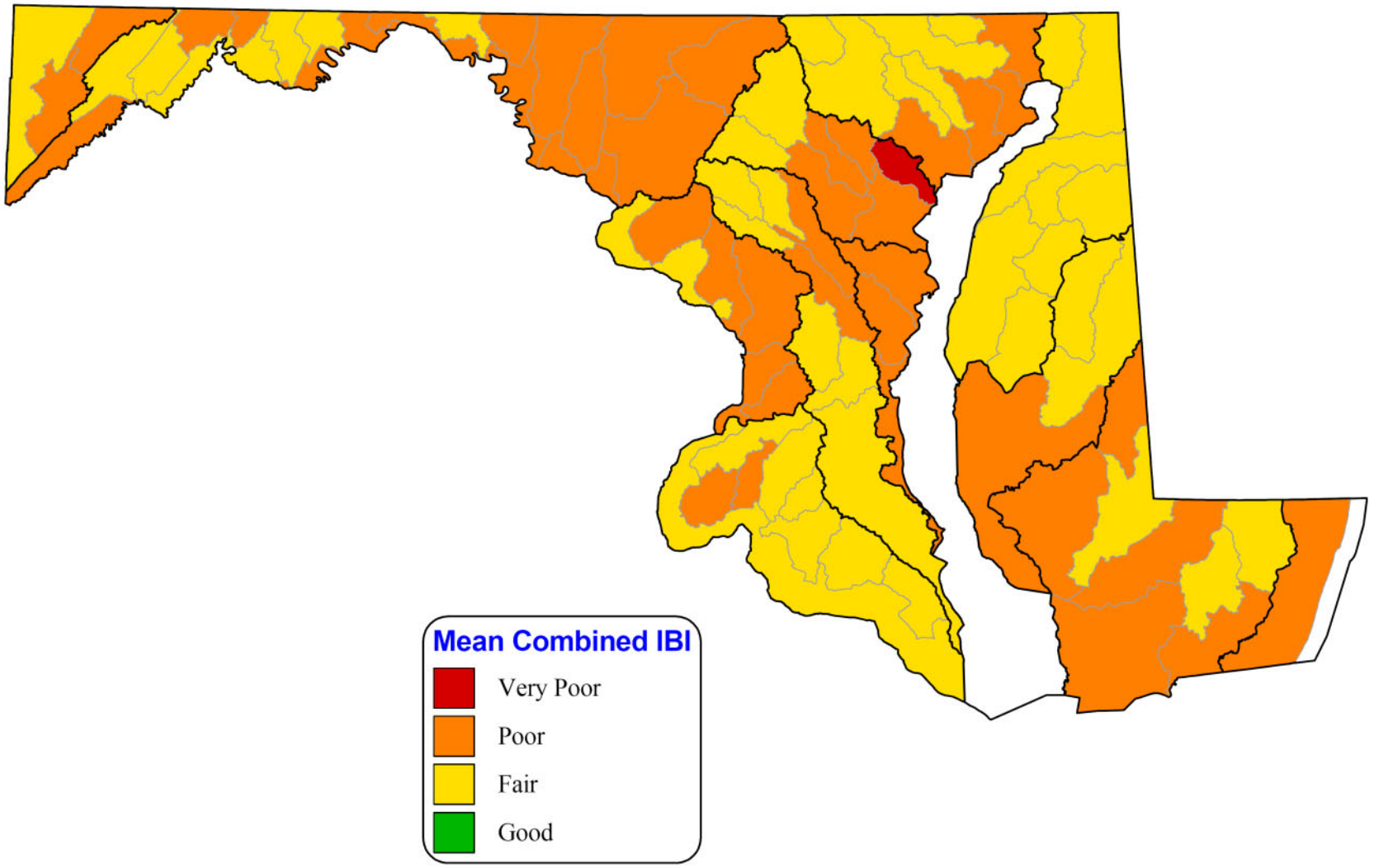

Figure 7-7. Distribution of mean Combined Biotic Index (CBI) scores by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. CBI score categories are 4.0-5.0 good, 3.0-3.9 fair, 2.0-2.9 poor, and 1.0-1.9 very poor.

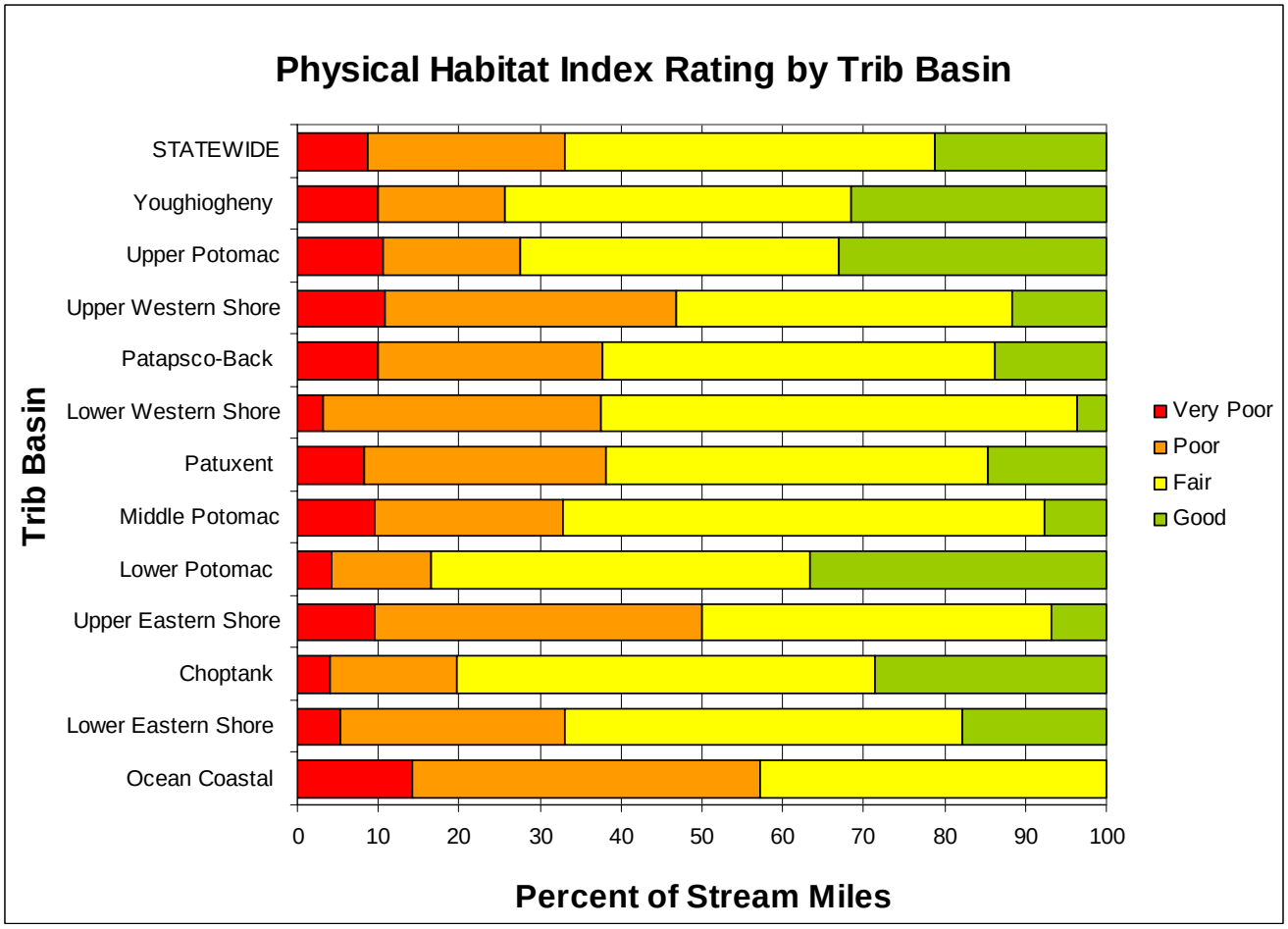

Figure 7-8. Physical Habitat Index (PHI) scores statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: 81-100 Minimally Degraded, 66-80 Degraded, 51-65 Partially Degraded, 0-50 Severely Degraded

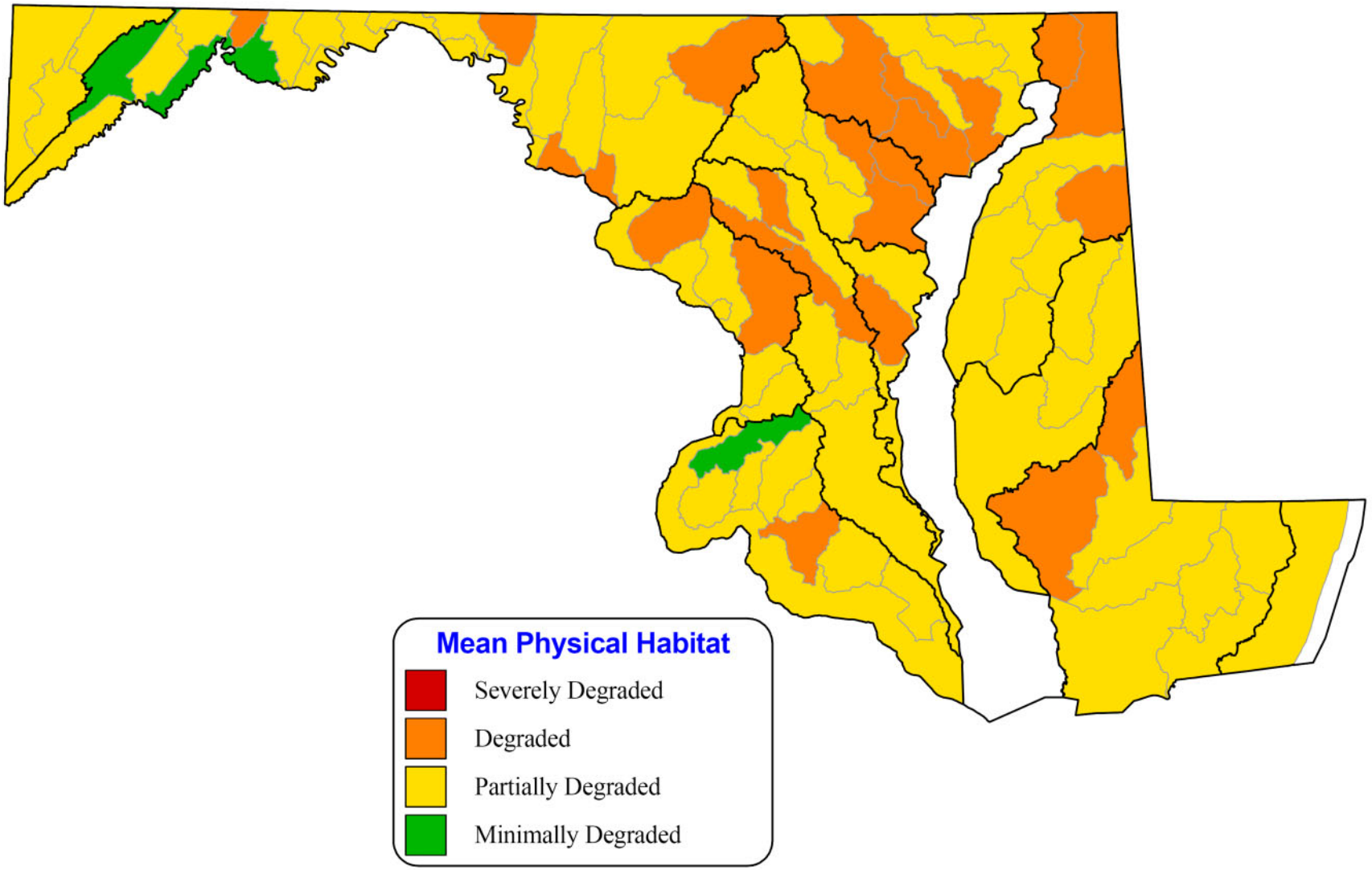

Figure 7-9. Distribution of mean Physical Habitat Index (PHI) scores by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. PHI score categories are 81-100 Minimally Degraded, 66-80 Degraded, 51-65 Partially Degraded, 0-50 Severely Degraded.

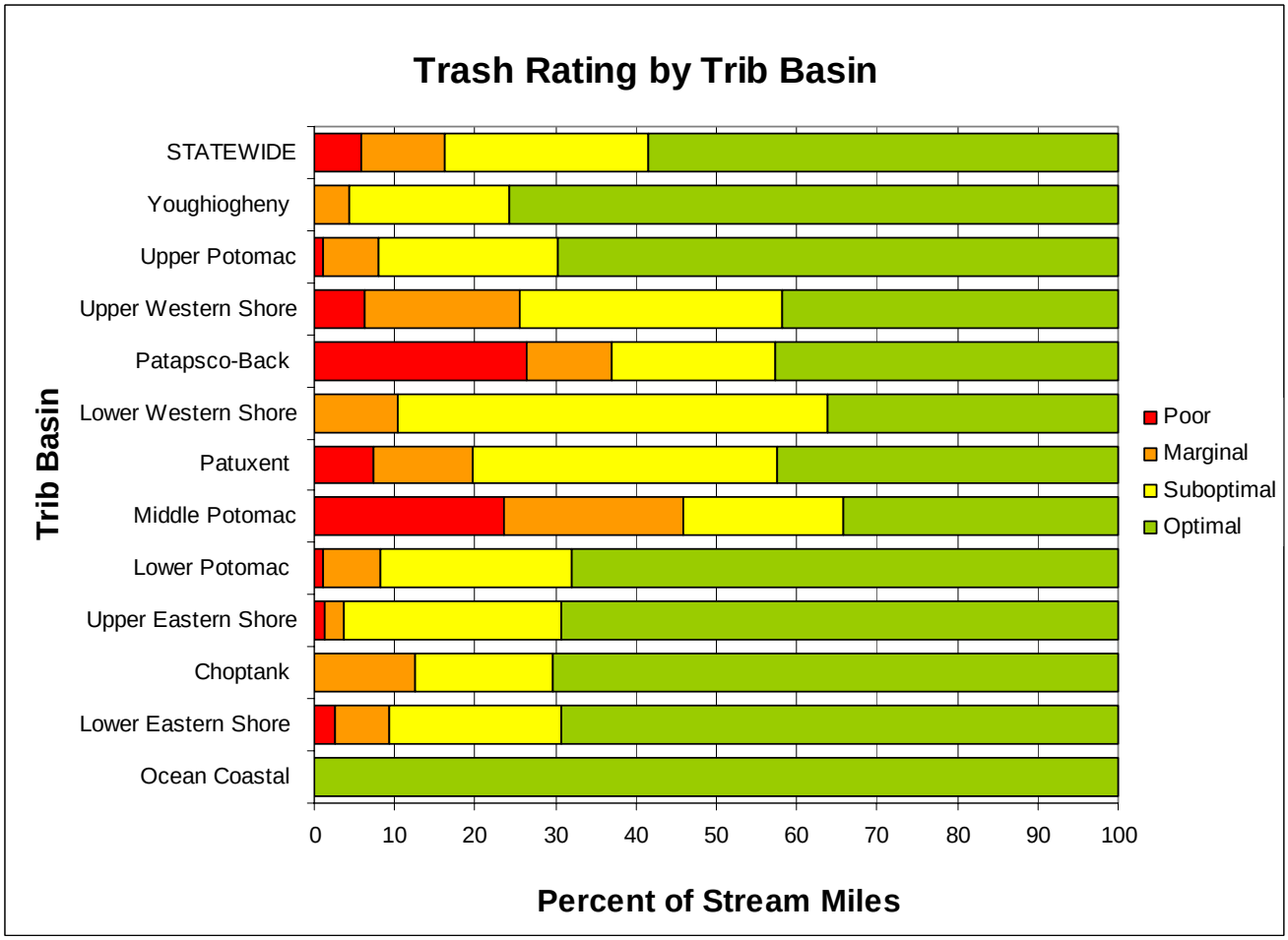

Figure 7-10. Trash Rating scores statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: 16-20 Optimal, 11-15 Suboptimal, 6-10 Marginal, 0-5 Poor

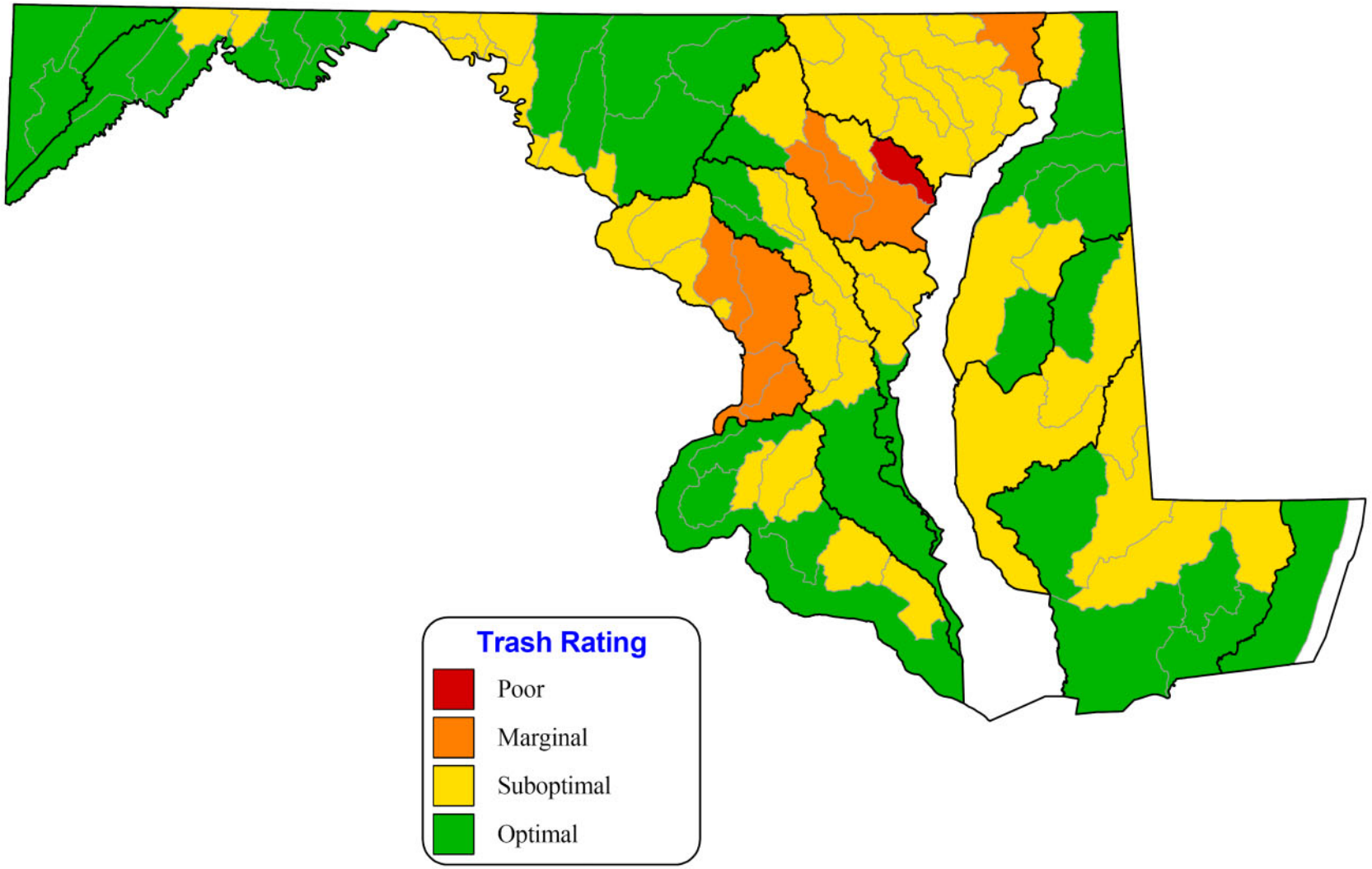

Figure 7-11. Distribution of mean Trash Rating scores by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. Trash rating categories are 16-20 Optimal, 11-15 Suboptimal, 6-10 Marginal, 0-5 Poor.

7.4 WATER CHEMISTRY

7.4.1 Acidification

Stream acidification is known to have detrimental effects on fish and other aquatic organisms, both directly through its effects on physiological function, and indirectly, by influencing the bioavailability and toxicity of metals to aquatic organisms. In evaluating the influence of acidification on stream biological communities, it is important to determine the extent and distribution of acidic and acid-sensitive streams.

During spring sampling in the Round 2 MBSS, an estimated 6% (SE 0.7) of stream miles statewide had pH < 5.5, while another 16% (SE 1.1) had pH 5.5-6.5. Figure 7-12 shows the distribution of the percentage of stream miles in different pH classes by Tributary Strategy Basin. The Lower Eastern Shore Basin had, by far, the most stream miles with pH < 5.5 (27% of stream miles, SE 4.8). Figure 7-13 shows the distribution of mean pH values statewide by PSU.

Acid Neutralizing Capacity (ANC) is a measure of the capacity of dissolved constituents in the water to react with and neutralize acids. It is used as an index of the sensitivity of surface water to acidification. The higher the ANC, the more acid a system can assimilate before experiencing a decrease in pH. ANC also indicates which systems are more likely to become acidified under episodic conditions. An ANC of 200 μeq/l is usually considered the threshold for defining acid-sensitive streams and lakes.

The following thresholds were used to characterize streams according to acid sensitivity: < 0 μeq/l (acidic), $0 \leq$ ANC < 50 μeq/l (highly sensitive to acidification), $50 \leq$ ANC < 200 μeq/l (sensitive to acidification), and $\geq$ 200 μeq/l (not sensitive to acidification). Statewide, 3% (SE 0.5) of streams were classified as acidic, 5% (SE 0.7) as highly sensitive, and 22% (SE 1.2) as sensitive. Two Tributary Strategy Basins contained more than 10% of stream miles that were rated acidic: the Lower Eastern Shore Basin (14%, SE 4.0), and the Ocean Coastal Basin (11%, SE 11.1). The percentage of stream miles in each of these ANC categories, by Tributary Strategy Basin, is shown in Figure 7-14 and the distribution of mean ANC values statewide by PSU is shown in Figure 7-15.

7.4.2 Nitrogen

In the absence of human influence, all streams contain a background level of nitrogen that is essential to the survival of the aquatic plants and animals in that system. However, during the last several hundred years, the amount of nitrogen in many stream systems has increased as a result of anthropogenic influences, such as agricultural runoff, wastewater discharge, and urban/suburban nonpoint sources.

Elevated nitrogen concentrations are one contributor to nutrient enrichment in aquatic systems. Excessive nitrogen may lead to the eutrophication of the waterbody, which decreases the level of dissolved oxygen available to aquatic organisms. Prolonged exposure to low dissolved oxygen situations can suffocate adult fish or lead to reduced recruitment. Increased nutrient loads are also thought to cause toxic algal blooms and to contribute to outbreaks of toxic organisms.

7.4.2.1 Nitrate-Nitrogen

Nitrate-nitrogen (NO_3) is one of the most common and stable forms of nitrogen found in aquatic systems and its toxicity to aquatic organisms is of particular concern. For the analysis of MBSS data, concentrations were assigned to several categories.

Statewide, the majority of stream miles (85%, SE 1.0) had NO_3 concentrations between 1.0 and 5.0 mg/l. Eight percent (SE 0.8) fell below 1.0 mg/l and seven percent fell above 5.0 mg/l. Three Tributary Strategy Basins had greater than 10% of stream miles with greater than 5.0 mg/l of NO_3 (Figure 7-16): the Choptank River Basin (33%, SE 6.8), the Lower Eastern Shore Basin (17%, SE 3.7), and the Ocean Coastal Basin (11%, SE 11.1). These are areas on the Eastern Shore of the state, with large amounts of agricultural land use contributing to the input of NO_3 to streams. Figure 7-17 shows the statewide distribution by PSU of mean NO_3 concentrations.

7.4.2.2 Nitrite-Nitrogen

Statewide, only 24% of stream miles (SE 1.3) had nitrite-nitrogen concentrations above 0.01 mg/l. Figure 7-18 shows the distribution of nitrite-nitrogen concentrations

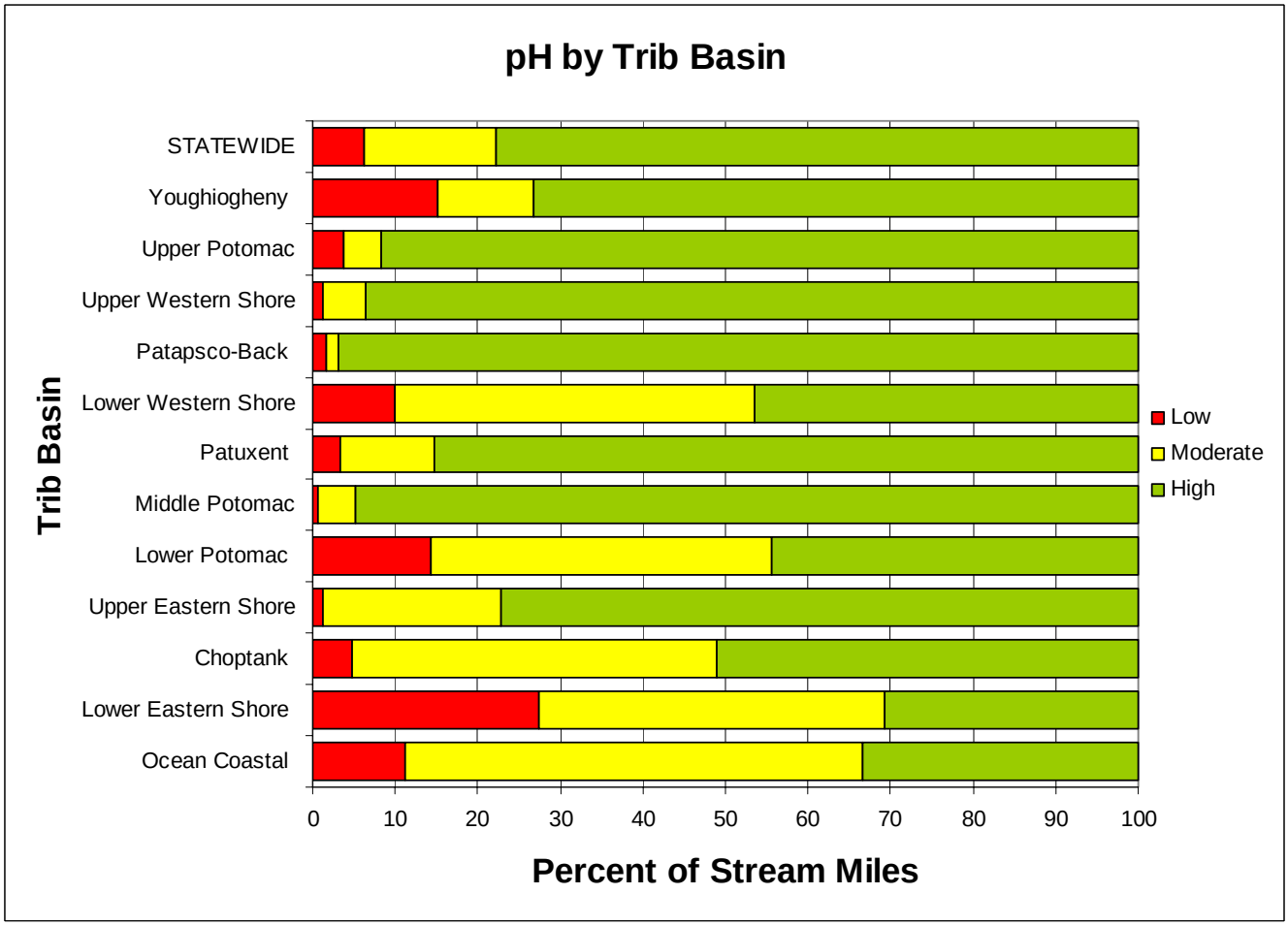

Figure 7-12. pH concentrations statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: < 5.5 low, 5.5-6.5 moderate, > 6.5 high

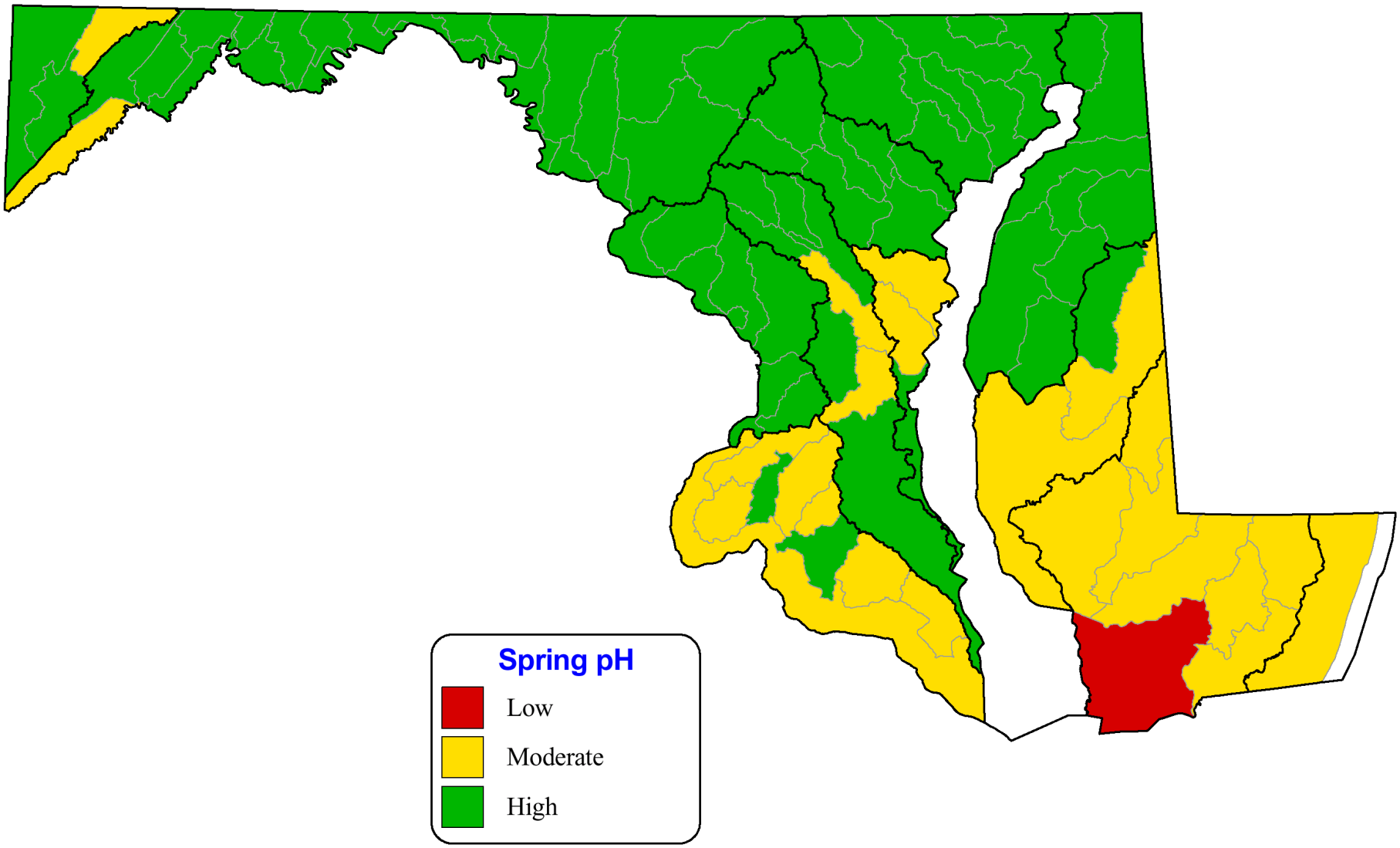

Figure 7-13. Distribution of mean pH concentration by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. Spring pH categories are < 5.5 low, 5.5-6.5 moderate, > 6.5 high.

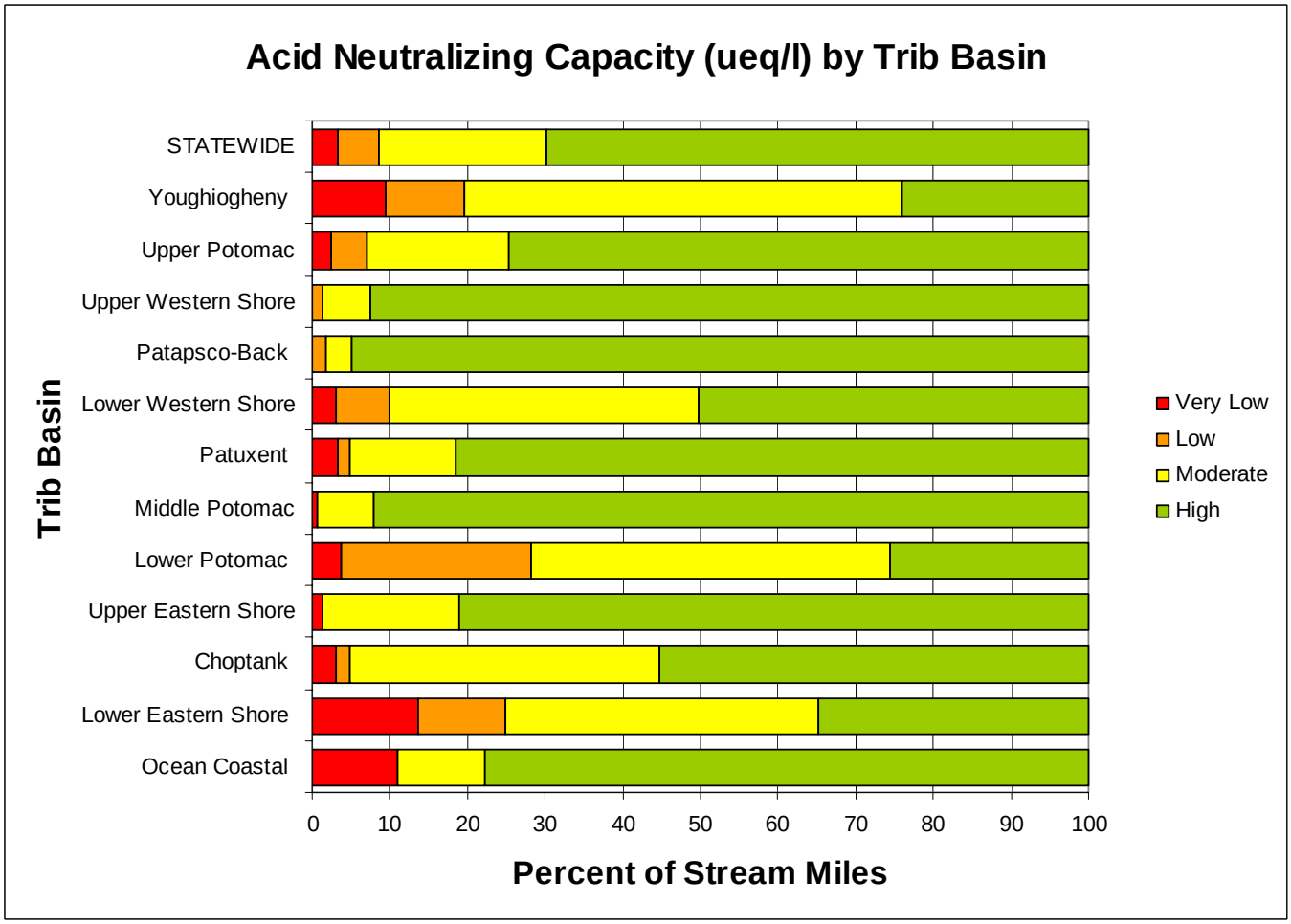

Figure 7-14. Acid Neutralizing Capacity (ANC) concentrations (μeq/l) statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: < 0 very low, 0-50 low, 50-200 moderate, > 200 high

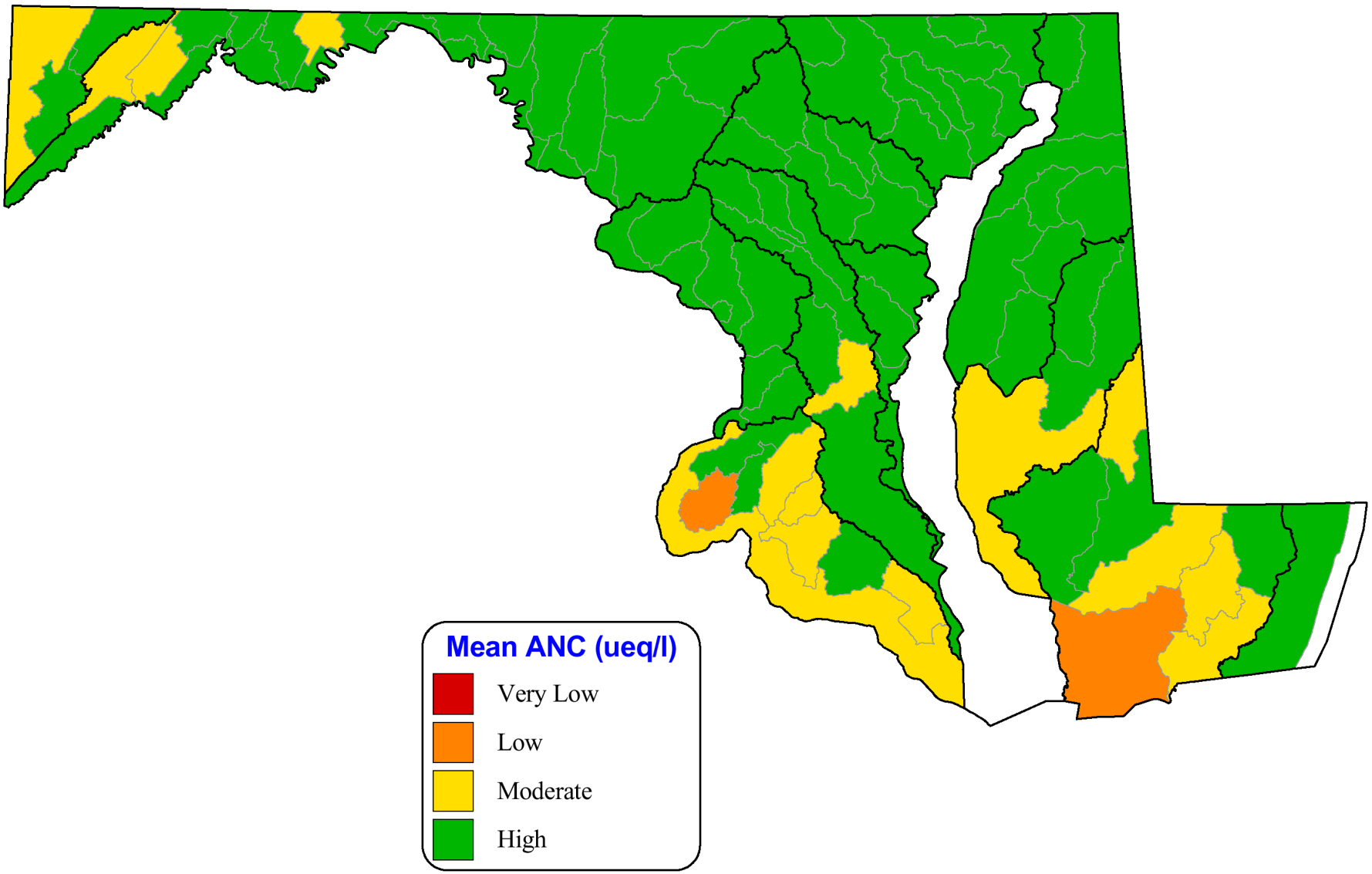

Figure 7-15. Distribution of mean Acid Neutralizing Capacity (ANC) concentration (µeq/l) by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. Mean ANC categories are < 0 very low, 0-50 low, 50-200 moderate, > 200 high.

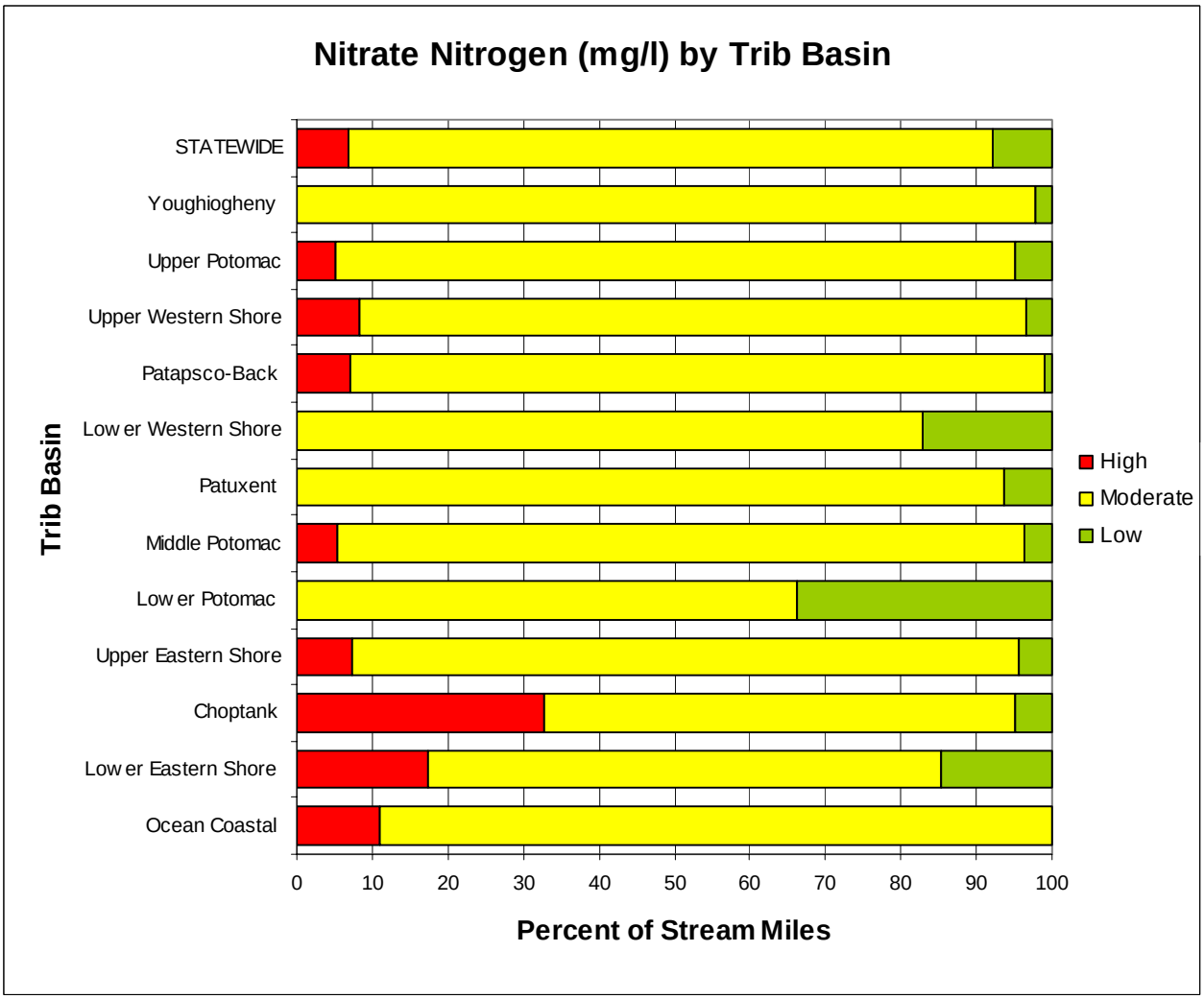

Figure 7-16. Nitrate-Nitrogen (NO_3) concentrations (mg/l) statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: < 1 low, 1-5 moderate, > 5 high

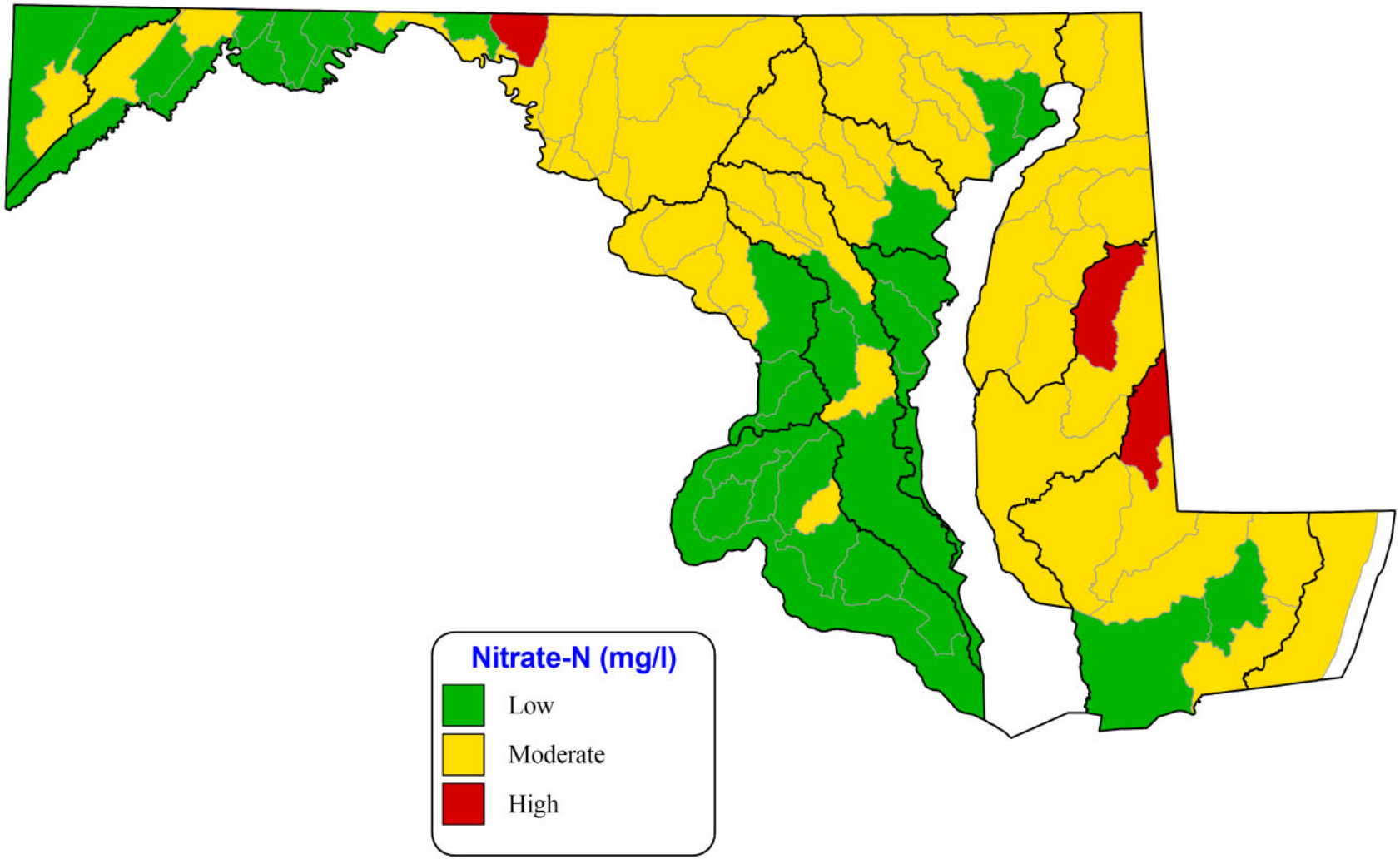

Figure 7-17. Distribution of mean nitrate-nitrogen concentration (mg/l) by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. Nitrate-Nitrogen categories are > 1 low, 1-5 moderate, < 5 high.

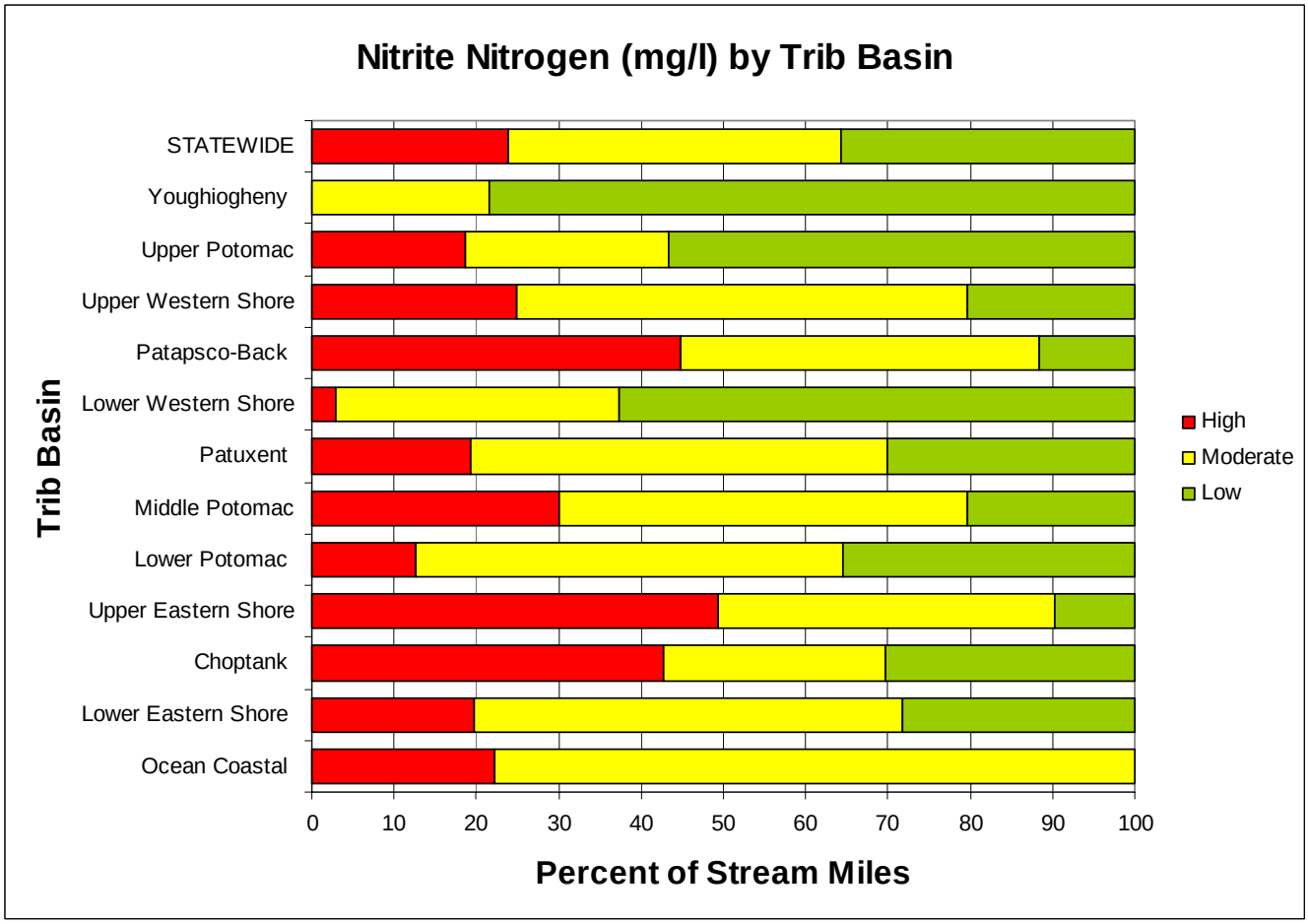

Figure 7-18. Nitrite-Nitrogen (NO_2) concentrations (mg/l) statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: < 0.0025 low, 0.0025-0.01 moderate, > 0.01 high

by Tributary Strategy Basin. The Upper Eastern Shore, the Patapsco/Back River and the Choptank River Basins had the highest percentage of stream miles with nitrite-nitrogen greater than 0.01 mg/l (49%, SE 5.9, 45%, SE 5.1, and 43% SE 9.0, respectively). The Youghiogheny River Basin had the greatest percentage of stream miles (78%, SE 6.3) with low nitrite-nitrogen concentrations. (< 0.0025 mg/l).

7.4.2.3 Ammonia

Statewide, the majority of stream miles (70%, SE 1.3) had low ammonia concentrations (< 0.03 mg/l). Figure 7-19 shows the distribution of ammonia concentrations by Tributary Strategy Basin. The Choptank River Basin had the greatest percentage of stream miles with high (> 0.07 mg/l) ammonia concentrations (32% of stream miles, SE 7.6), followed by the Upper Eastern Shore (26%, SE 4.9). The western-most Tributary Strategy Basins: the Upper Potomac Basin (88%, SE 2.2), the Upper Western Shore Basin (80%, SE 3.7), and the Youghiogheny River Basin (94%, SE 4.2) had the greatest percentage of stream miles with low (< 0.03 mg/l) ammonia concentrations.

7.4.2.4 Total Nitrogen

Statewide, 47% (SE 1.4) of stream miles had total nitrogen concentrations that fell between 1.5 and 7.0 mg/l. An additional 49% (SE 1.3) of stream miles had total nitrogen concentrations less than 1.5, while only 4% (SE 0.6) of stream miles had total nitrogen concentrations greater than 7.0 mg/l. Three basins had greater than 10% of stream miles with total nitrogen concentrations greater than 7.0: the Choptank River Basin (21% of stream miles, SE 6.9), the Lower Eastern Shore Basin (13%, SE 3.3), and the Ocean Coastal Basin (11%, SE 11.1). The Tributary Strategy Basin with the greatest number of stream miles with low (< 1.5 mg/l) concentrations of total nitrogen is the Lower Western Shore Basin (96% of stream miles, SE 3.6).

7.4.3 Phosphorus

Elevated levels of phosphorus are associated with agricultural impacts, especially those from poultry farming on the Eastern Shore. Statewide, the majority (54% of stream miles, SE 1.4) of stream miles have low (< 0.025 mg/l) concentrations of total phosphorus. The Tributary Strategy Basins with the greatest number of stream miles with high (> 0.07 mg/l) concentrations of total phosphorus are located on the Eastern Shore (Figure 7-21): the Ocean Coastal Basin (44% of stream miles, SE 17.5) and Upper Eastern Shore Basin (43%, SE 5.8). Statewide distributions of mean total phosphorus by PSU are shown in Figure 7-22.

Ortho-phosphate patterns were similar to those of total phosphorus (Figure 7-23). Seventy percent of stream miles (SE 1.4) statewide have low concentrations of ortho-phosphate (< 0.008 mg/l). The Ocean Coastal Basin has the greatest percentage of stream miles with high ortho-phosphate concentrations (67%, SE 16.6) and the Youghiogheny River Basin has the greatest percentage of stream miles with low ortho-phosphate concentrations (100% of stream miles, SE 0.00).

7.4.4 Dissolved Oxygen

The majority of stream miles (88%, SE 1.0) statewide had dissolved oxygen (DO) concentrations greater than 5 mg/l; the Code of Maryland Regulations (COMAR) standard and a level generally considered healthy for aquatic life. Figure 7-24 shows the distribution of DO concentrations by Tributary Strategy Basin. As expected, the greatest number of stream miles with low DO (< 3 mg/l) concentrations occurs on the Eastern Shore in the Lower Eastern Shore Basin (24% of stream miles, SE 4.7) and the Choptank River Basin (17% of stream miles, SE 6.4). This is an area of the state where swampy blackwater streams and sluggish waters are naturally lower in DO, but also susceptible to biological oxygen demand (BOD) loading from anthropogenic sources. Statewide distributions of mean dissolved oxygen concentration by PSU are shown in Figure 7-25.

7.5 SUMMARY

The results from MBSS sampling in 2000-2004 indicate that about half of streams in Maryland are rated Fair or Good. Conversely, approximately 46% of streams are rated Poor or Very Poor by the combined fish and benthic macroinvertebrate IBIs (CBI). The distribution of stream conditions among Maryland's Tributary Strategy Basins is fairly even across the state. All 12 basins (Chesapeake Bay Tributary Basins plus Youghiogheny and Ocean Coastal Basins) are in predominately Fair or Poor condition, according to the CBI.

The statewide mean fish IBI is 2.97 (standard error or SE of 0.04), a high Poor, almost Fair rating. Similarly, the statewide mean benthic macroinvertebrate IBI is 3.07 (SE 0.03) and the statewide mean CBI is 3.00 (SE 0.03). The statewide mean PHI score is 70.27 (SE 0.44), or Degraded. Statewide, an estimated 59% (SE 1.5) of

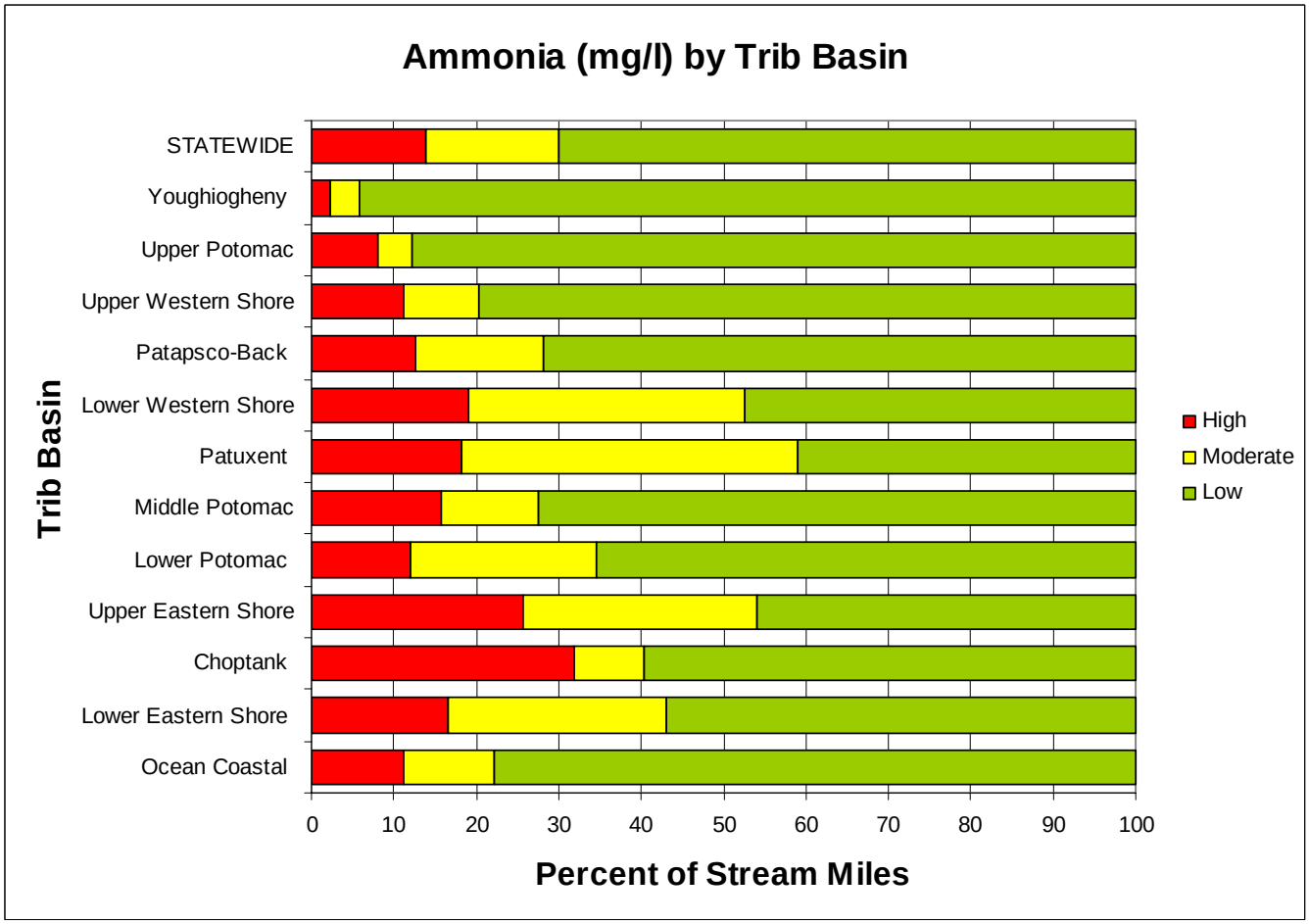

Figure 7-19. Ammonia (NH_3) concentrations (mg/l) for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category : < 0.03 low, 0.03-0.07 moderate, > 0.07 high

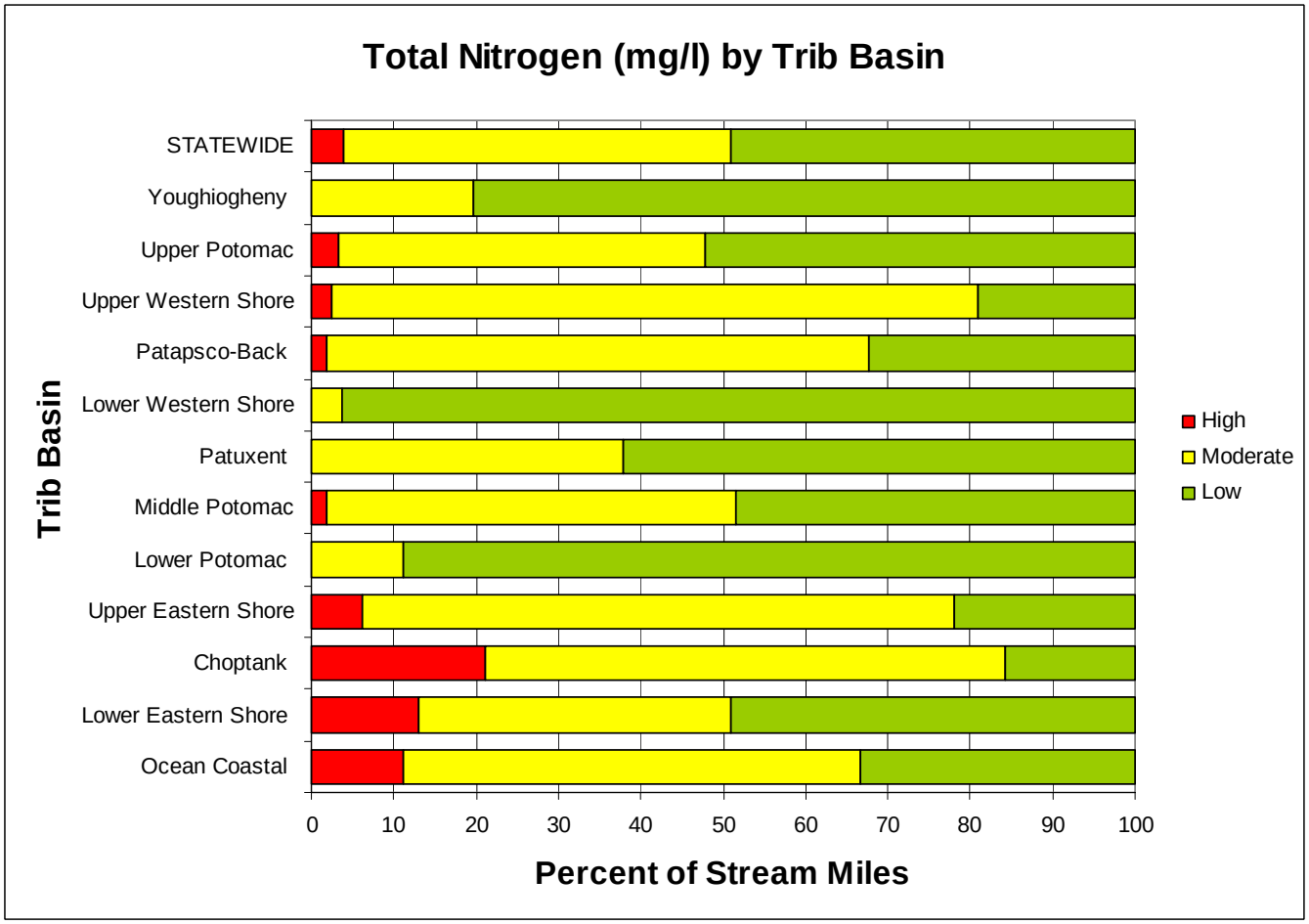

Figure 7-20. Total Nitrogen (TN) concentrations (mg/l) statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: < 1.5 low, 1.5-7.0 moderate, > 7.0 high

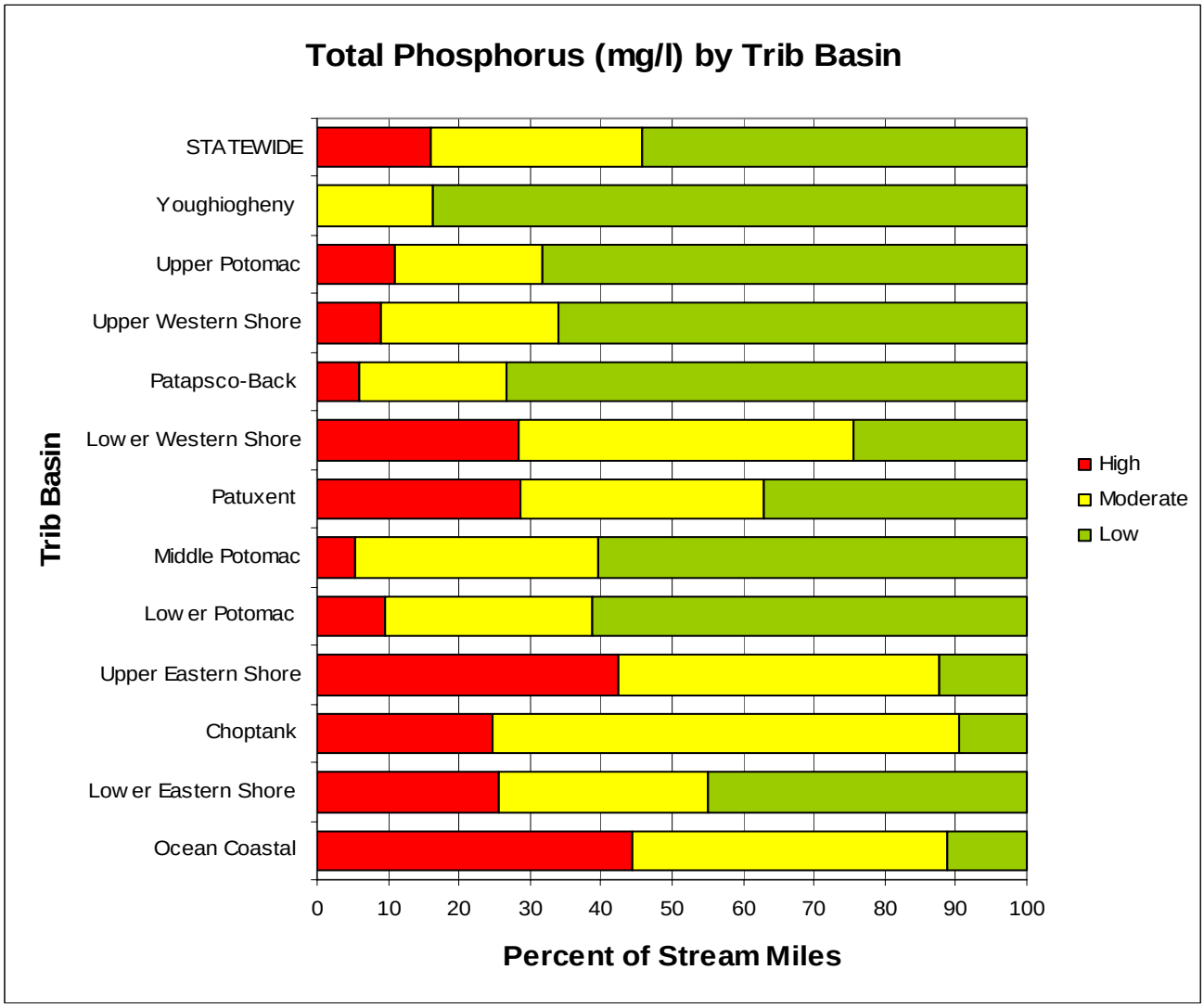

Figure 7-21. Total Phosphorus (TP) concentrations (mg/l) statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: < 0.025 low, 0.025-0.07 moderate, > 0.07 high

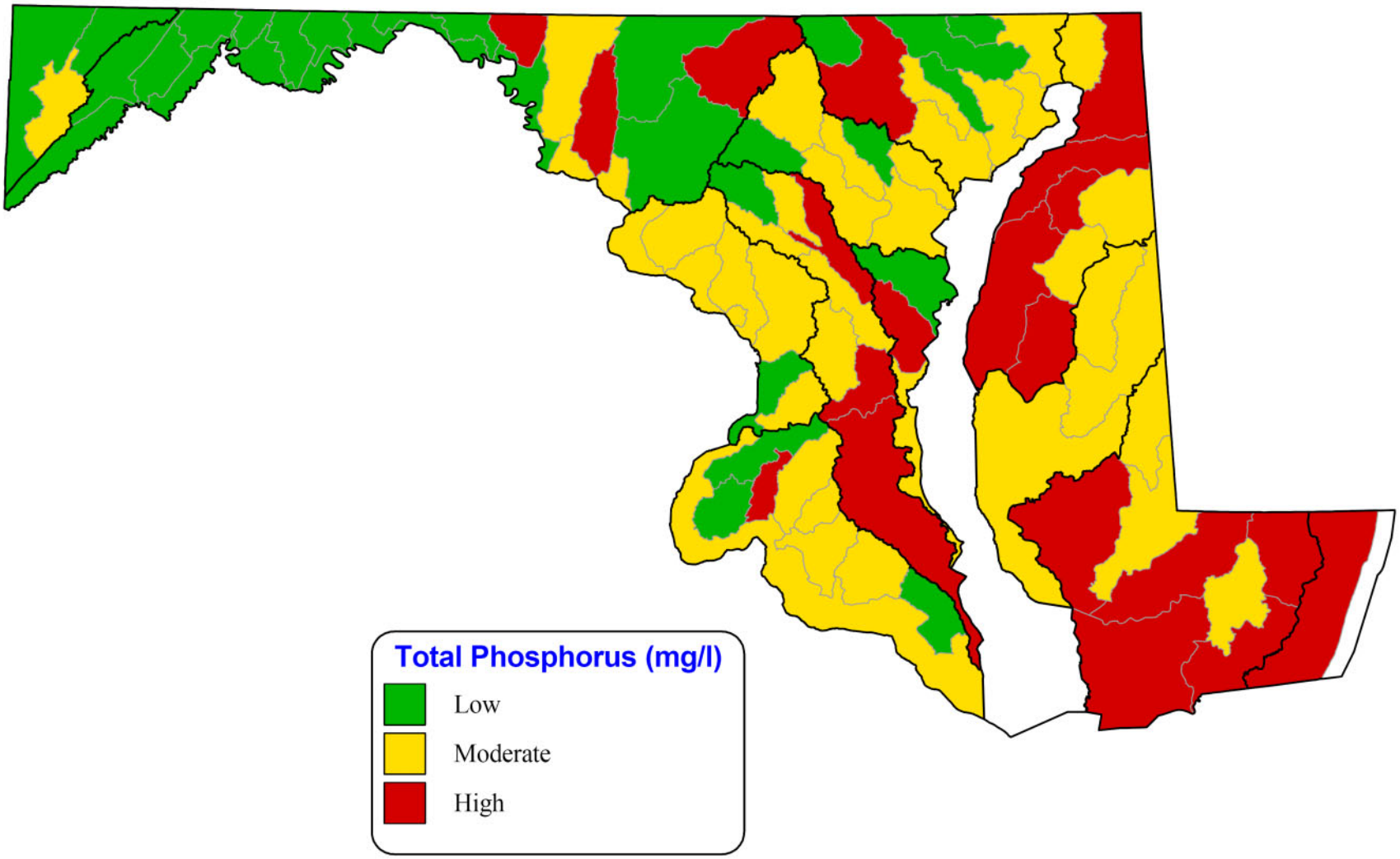

Figure 7-22. Distribution of mean total phosphorus concentration (mg/l) by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. Total phosphorus categories are < 0.025 low, 0.025-0.07 moderate, > 0.07 high.

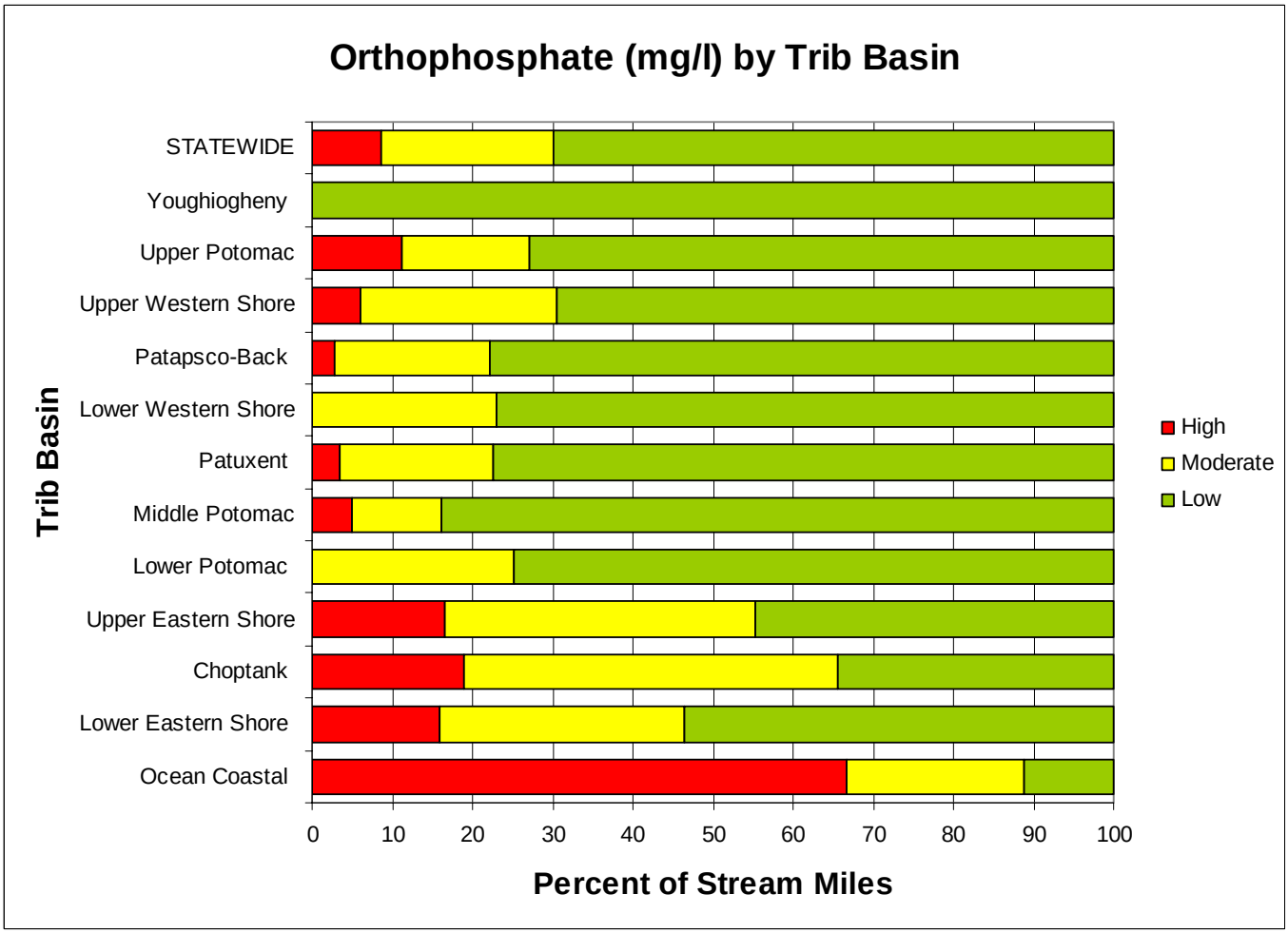

Figure 7-23. Ortho-phosphate (ortho-PO_4) concentrations (mg/l) statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: < 0.008 low, 0.008-0.03 moderate, > 0.03 high

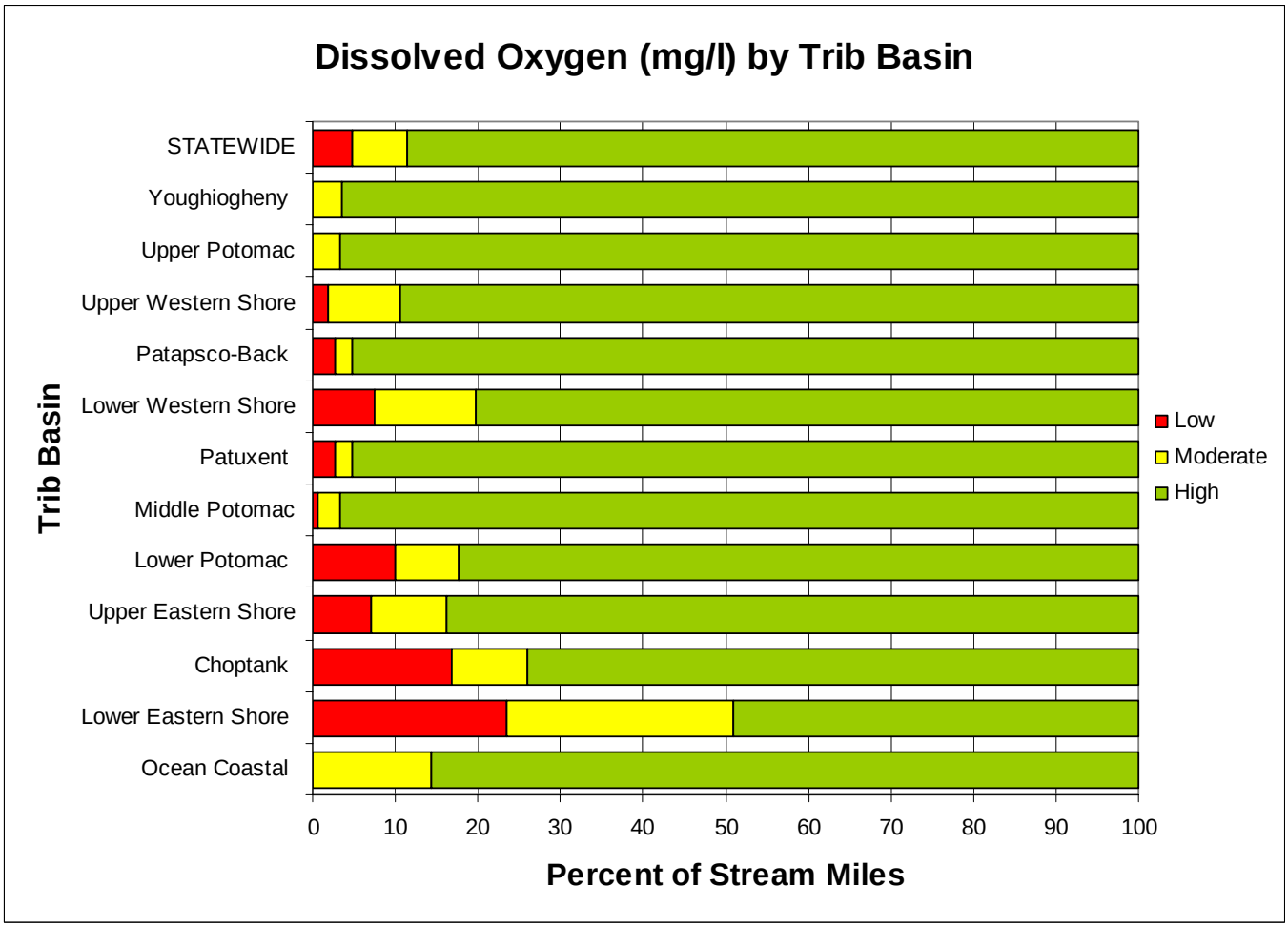

Figure 7-24. Dissolved oxygen (DO) concentrations (mg/l) statewide and for Tributary Strategy Basins sampled in the 2000-2004 MBSS, as the percentage of stream miles in each category: < 3 low, 3-5 moderate, > 5 high

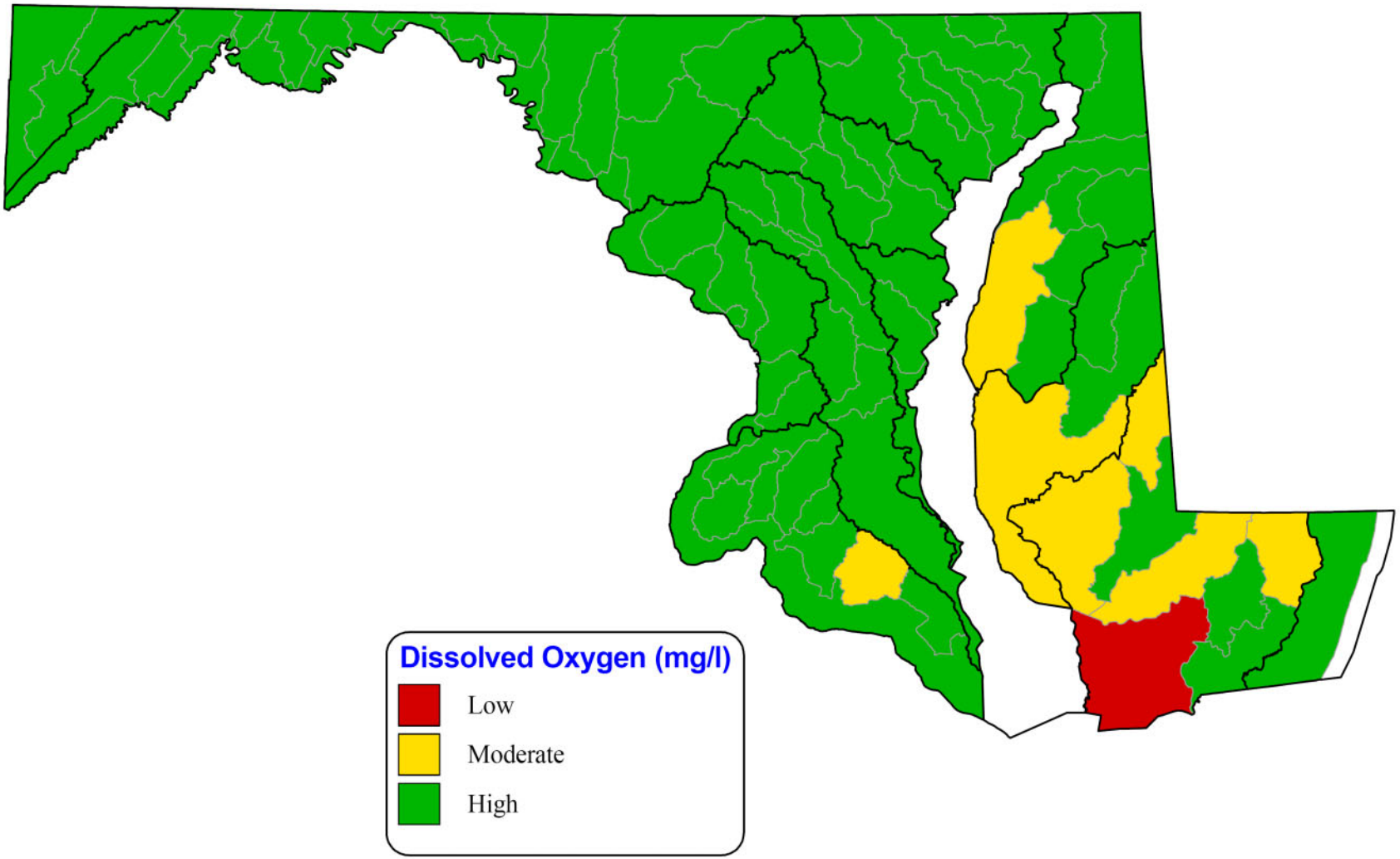

Figure 7-25. Distribution of mean dissolved oxygen concentration (mg/l) by Primary Sampling Unit (PSU) for the 2000-2004 MBSS. Bold lines indicate Tributary Strategy Basins. Dissolved Oxygen categories are < 3 low, 3-5 moderate, > 5 high.

stream miles were rated Optimal for their trash rating (scoring ≥ 16 out of 20), meaning trash was minimal. Only 6% (SE 0.6) of stream miles were rated as Poor for trash. During spring sampling in the 2000-2004 MBSS, an estimated 6% (SE 0.7) of stream miles statewide had pH < 5.5. Statewide, the majority of stream miles (85%, SE 1.0) had nitrate-nitrogen (NO_3) concentrations between 1.0 and 5.0 mg/l. Eight percent (SE 0.8) fell below 1.0 mg/l and seven percent above (SE 0.7) 5.0 mg/l. Statewide, only 24% of stream miles (SE 1.3) had NO_2 concentrations above 0.01 mg/l. Also, the majority of stream miles in the state (70%, SE 1.3) had low ammonia concentrations (< 0.03 mg/l). Forty-seven percent (SE 1.4) of stream miles had total nitrogen concentrations that fell between 1.5 and 7.0 mg/l. The majority (54%, SE 1.4) of stream miles have low (< 0.025 mg/l) concentrations of total phosphorus. Statewide, only nine percent (SE 0.9) had ortho-phosphate concentrations above 0.03mg/l. The majority of stream miles (88%, SE 1.0) statewide had dissolved oxygen (DO) concentrations greater than 5 mg/l.

These results confirm that a large proportion of our streams are in poor condition and many more are in worse condition than we desire. The first step in "fixing" these streams is determining why they are "broken." The MBSS is pursuing stressor identification (i.e., the diagnosis of stream problems) for the degraded streams identified in this volume to support stream protection and restoration efforts by Maryland DNR, MDE, and other organizations (see Volume 14, Stressors Affecting Maryland Streams). Stressors can be organized according to the five major determinants of biological integrity in aquatic ecosystems: water chemistry, energy source, habitat structure, flow regime, and biotic interactions. The results in this volume describe the extent of physical habitat, acidification, and nutrient stressors, statewide and by Tributary Basin. The MBSS directly measures other stressors (e.g., invasive species) and analyzes ancillary information (such as land use), but does not consider some stressors, such as pesticides.

Stressor identification results to date include the strong effect that acidification (especially low acid neutralizing capacity, ANC) has on both fish and benthic macroinvertebrate communities. While acid mine drainage (AMD) is among the most severe stressors (producing a strong effect when present), the extent of streams affected by AMD (1% of all stream miles) is small compared to other stressors, including acidic deposition. Aquatic nonnatives and invasive plants are the stressors affecting the greatest number of stream miles statewide (more than 50%). Nutrient pollution also affects Maryland streams as evidenced by the strong relationship between sensitive benthic taxa (Ephemeroptera, Plecoptera, and Trichoptera) and the ratio of total nitrogen (TN) to total phosphorus (TP). The percentage of agricultural land use is a good predictor of nitrate levels in streams. Degradation of instream physical habitat is the stressor most often resulting in the loss of individual fish species. Urban land use and its concomitant impervious surfaces strongly affect the fish, benthic, and salamander communities in streams to the point that other stressors are obscured and management solutions may be limited. These results also show where Maryland streams are in their best condition (IBIs >4 or higher). These streams warrant special attention for protection as well (see Volume 9 Stream and Riverine Biodiversity).

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